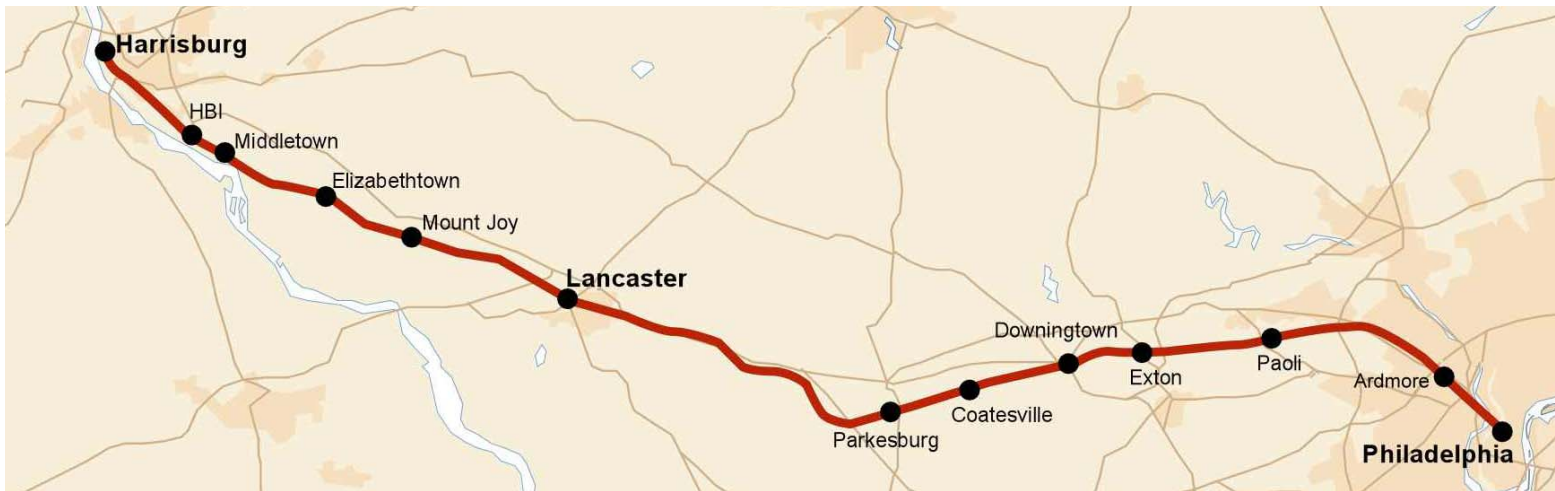


**VOLUME I**  
**Executive Summary and Main Report**

**Technical Monograph:  
Transportation Planning  
for the Philadelphia–Harrisburg  
“Keystone” Railroad Corridor**



**Federal Railroad Administration  
United States Department of Transportation**

**March 2004**

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| <b>16. Abstract</b><br><br>Should the Commonwealth of Pennsylvania desire to upgrade the railroad corridor between Philadelphia and Harrisburg for improved passenger service that meets a specific travel time goal, a number of infrastructure improvements would be needed. This monograph enumerates, describes, and costs a set of improvements that could, in combination, support a trip time goal of 90 minutes between Philadelphia (Suburban Station) and Harrisburg. The operational implications of such a service are discussed. This monograph may be of technical assistance to other States that are contemplating similar rail passenger service projects. |   |  |   |  |
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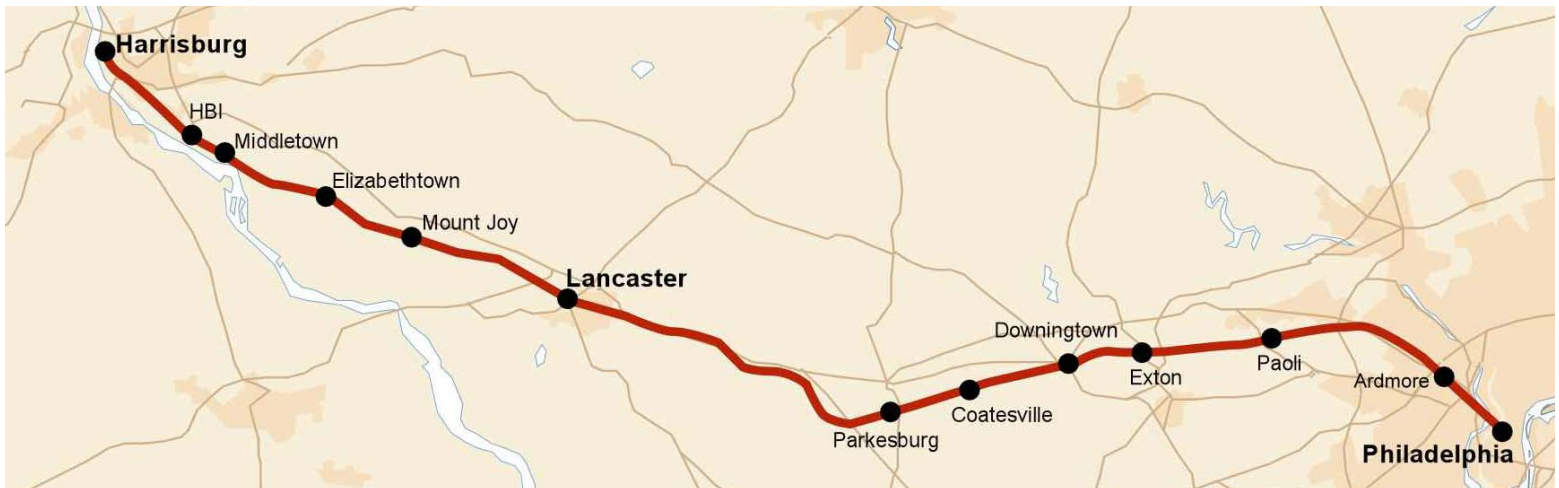
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## EXECUTIVE SUMMARY

# Technical Monograph: Transportation Planning for the Philadelphia–Harrisburg “Keystone” Railroad Corridor



**Federal Railroad Administration  
United States Department of Transportation**

**March 2004**

This technical monograph describes a set of potential long-term improvements to the Keystone Corridor, a mature, high-volume passenger railroad linking Philadelphia and Harrisburg, Pennsylvania. The monograph discusses the origin and purpose of the underlying studies; the corridor's current<sup>1</sup> condition and usage; its assumed transportation role in the 21<sup>st</sup> Century; and a set of possible improvements—both corridor-wide and site-specific—that would allow the Keystone Corridor to provide enhanced intercity and commuter train services, should the Commonwealth of Pennsylvania elect to foster such upgraded operations. Further details, as well as methodology, appear in the Main Report and in the Appendixes (in Volume II).

## BACKGROUND OF THE STUDY

The Federal Railroad Administration (FRA) undertook this technical study in conjunction with the National Railroad Passenger Corporation (Amtrak), the Pennsylvania Department of Transportation (PennDOT), and the Southeastern Pennsylvania Transportation Authority (SEPTA), in support of the Congressionally-mandated comprehensive transportation plan for the portion of the Northeast Corridor (NEC) between Washington and New York.<sup>2</sup> Because the Keystone and Northeast Corridors evolved over a century as integral parts of a single transportation company (the Pennsylvania Railroad or “PRR”), tight operating, marketing, and physical linkages still exist between the two routes, both of which Amtrak owns. Moreover, at the inception of this study, the Keystone Corridor had acquired an importance of its own, both through its Congressional designation as a “high-speed corridor”<sup>3</sup> and through some jointly expressed intentions on the part of PennDOT and Amtrak to invest in the line.<sup>4</sup> This monograph, therefore, was prepared as a resource document both for planning on the NEC main line and for analysis of such potential betterments on the Keystone Corridor as the Commonwealth of Pennsylvania may choose to foster.

## TODAY'S KEYSTONE CORRIDOR

**Extent.** The Keystone Corridor covers 104 miles between Harrisburg, Lancaster, Philadelphia's “Main Line” suburbs, 30<sup>th</sup> Street Station just west of Center City Philadelphia, and Suburban Station at Philadelphia's core. Through the Center City Connection, a physical linkage exists to additional Center City and north suburban stations.

**Service.** As of the year 2000, the Keystone Corridor supported a wide range of passenger services. SEPTA provided a very frequent commuter service to Paoli and Malvern, with some

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<sup>1</sup> I.e., during the late 1990s, in which period the analysis took place.

<sup>2</sup> 1996 Appropriations Act for the Department of Transportation and related agencies.

<sup>3</sup> In Section 1103(c) of the Transportation Equity Act for the 21st Century, enacted June 9, 1998 as Public Law 105-178. The original designation covered the line between Philadelphia and Harrisburg, to which the term “Keystone Corridor” is restricted in this report. On October 11, 2000, the U.S. Secretary of Transportation extended the definition of the designated Keystone Corridor to include the Harrisburg–Pittsburgh route.

<sup>4</sup> As of 1999, Amtrak and PennDOT were intending to invest approximately \$140 million in the Keystone Corridor, to be allocated proportionately as follows.

|                   |     |                    |     |                 |    |
|-------------------|-----|--------------------|-----|-----------------|----|
| Equipment:        | 32% | Signals:           | 15% | Bridge repairs: | 8% |
| Track structures: | 30% | Electric traction: | 11% | Stations:       | 4% |

trains serving Thorndale to the west. Amtrak provided seven daily round trips between Harrisburg and 30<sup>th</sup> Street Station, Philadelphia, of which six also served Trenton and New York. (Most of these trains were Diesel-powered, due to Amtrak's shortages of electric equipment.) Two daily round trips made use of the Keystone Corridor to link Philadelphia and Harrisburg with Pittsburgh and points west.<sup>5</sup> Freight service was minimal, with local trains only and no through operations.

The existing Amtrak services do not exploit all the marketing possibilities inherited from the PRR. Specifically, trains from Harrisburg to Philadelphia stop at the Lower Level of 30<sup>th</sup> Street Station, rather than using the Upper Level and continuing to Suburban Station or beyond, in Philadelphia's Center City. Furthermore, all trains between Harrisburg, the Philadelphia Main Line, and New York make a time-consuming stop and reverse move at 30<sup>th</sup> Street Station rather than bypassing it as both the PRR and Amtrak once did. With passengers bound for Philadelphia's center needing to make a transfer at 30<sup>th</sup> Street Station, and with through passengers spending about three-quarters of an hour more time on the train than their predecessors did, the present service offering of the Keystone Corridor clearly does not fulfill either the standards set in the recent past or the potentials inherent in the infrastructure.<sup>6</sup> As a result, long-term traffic volumes have not achieved levels that might be expected on a line connecting Pennsylvania's capital with its largest city. Among the objectives of this report is to provide information on a possible service pattern that might, at some future time and under State sponsorship, better suit this time-sensitive market.

***Fixed Plant.*** Other than the NEC main line, the Keystone Corridor is the Nation's only electrified intercity passenger route,<sup>7</sup> and the only Amtrak corridor that is almost completely grade separated from highway traffic. These attributes, coupled with its maximum authorized speeds up to 90 mph,<sup>8</sup> generally ample capacity, and excellent connectivity both with Center City Philadelphia and with Amtrak's New York–Washington route, could someday allow the Keystone Corridor to attract and accommodate heavier traffic volumes than now obtain, should the Commonwealth of Pennsylvania wish it to do so.

However, the Harrisburg–Philadelphia line attained its basic physical form with the completion of electrification in 1938—over 65 years ago. Since then, major subsystems have deteriorated, including the signals, the electric power distribution system, and certain track components. At some locations, maximum authorized speeds have declined to 70 mph due to poor infrastructure conditions. Moreover, the design of the fixed plant reflects the needs of the prewar PRR (with heavy through freight and intercity passenger traffic), rather than modern transportation demands. Thus, despite the line's market potential and unique design characteristics, significant investment could be required to enable the Keystone Corridor to

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<sup>5</sup>These long-distance trains do not provide local service between Harrisburg and Philadelphia, however.

<sup>6</sup>For an explanation of how the service evolved as it did in recent decades, see the Main Report.

<sup>7</sup>With the arguable exception of the South Shore Line, a former interurban operation, between Chicago and South Bend, Indiana (approximately 100 miles).

<sup>8</sup>This speed limit is higher than that of any other corridor in the U.S., except for the NEC proper, Los Angeles–San Diego, a segment of Chicago–Detroit, and New York–Albany. In addition, certain properties of the former Santa Fe Railway allow 90 mph speeds on the Chicago–Los Angeles long distance route.

support such upgraded intercity passenger service as the Commonwealth of Pennsylvania may wish to effect.

## SERVICE GOALS AND THEIR ACHIEVABILITY

As of the year 2000, PennDOT and Amtrak had posited a set of goals that would, if implemented, set the standard for the Keystone Corridor operations in the year 2015. Pertaining to intercity high-speed and regional commuter services, these goals ultimately led to the operating schedules that formed the analytical basis for this monograph. Freight and long-distance intercity train volumes and routings were assumed to remain constant.<sup>9</sup>

***Intercity high-speed services.*** For 2015, PennDOT and Amtrak contemplated a 90-minute trip time between Philadelphia's Suburban Station and Harrisburg, with three intermediate stops,<sup>10</sup> at a maximum authorized speed (MAS) of 110 mph. The future service would include one-hour headways during peak periods and two-hour headways off-peak. Such a service would necessarily make use of electrically-powered trains.<sup>11</sup>

Computerized simulations of train performance have confirmed the achievability of a reliable, 90-minute schedule between Center City Philadelphia and Harrisburg with currently available, off-the-shelf equipment. Such a projection assumes completion of the improvements examined in this report.

Amtrak and PennDOT also anticipated faster access to New York City for Keystone Corridor riders. Under such a scenario, two direct, daily, electrically-powered round trips would link Harrisburg, Philadelphia's Main Line, and New York—bypassing 30<sup>th</sup> Street Station. Also assumed were two Harrisburg–30<sup>th</sup> Street Station–New York through round trips, with longer schedules than the direct trains. In total, according to the projections underlying this monograph, Amtrak would operate four Harrisburg–New York trains daily in each direction.

***Commuter services.*** The existing, mature service between Center City Philadelphia and Paoli/Malvern would remain essentially the same; longer trains would absorb any increases in demand. SEPTA projected a significant increase in train frequencies at stations west of Malvern to Thorndale, with limited additional service to Atglen; these trains would run nonstop between Paoli and 30<sup>th</sup> Street Station. If implemented, some of the intercity corridor improvements could directly benefit express commuter services by creating a high-speed path to and from 30th Street Station.

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<sup>9</sup> If freight traffic routings and volumes change materially, the design of the Keystone Corridor would be susceptible to noticeable changes in any affected segments.

<sup>10</sup> One of the intermediate stops would be the Upper Level of 30<sup>th</sup> Street Station. As shown in Chapter 5 of the Main Report, a schedule with up to seven intermediate stops could have a reliable running time of just five minutes more, i.e. 95 minutes, between Harrisburg and Suburban Station.

<sup>11</sup> Electrically-powered trains would make use of the line's electric traction system and would be absolutely necessary to operate through from Harrisburg to Philadelphia's underground Suburban Station and to Pennsylvania Station, New York.

The projected 2015 schedule also assumes a commuter rail service to Harrisburg from Lancaster and Carlisle. Such a commuter service would include half-hour headways between Harrisburg and its International Airport.

***Interaction of the two services.*** Studies of future operating patterns and schedules showed that high-speed intercity services, if established, would not degrade, and could in fact improve, existing or proposed Keystone Corridor commuter services, and would be compatible with proposed Harrisburg commuter service as well. This conclusion assumes that the Commonwealth of Pennsylvania will elect to complete the possible improvements described in this monograph, and that the exemplary cooperation between SEPTA and Amtrak,—which has helped to produce a 90 percent on-time performance record for the line,—will continue.

## CONTEMPLATED IMPROVEMENTS

If effected, the contemplated improvements are projected to enable the Keystone Corridor to reliably meet high-speed rail travel time goals, while assuring capacity for all assumed services.

The Main Report addresses in depth two categories of improvements: those dealing with corridor-wide components and those treating site-specific opportunities and challenges.

***Corridor-wide improvements.*** For analytical purposes, this technical monograph assumes that the following items would be applied to the Keystone Corridor as a whole:

- **Track geometry.** The Keystone Corridor between Harrisburg and Philadelphia contains more than 100 curves, many of which exceed two degrees of curvature and are restricted to a maximum speed of 80 mph. Furthermore, the existing track geometry of this nearly 200-year-old railway does not follow modern engineering practice pertaining to the transition zones (spirals) between straight and curved track and the introduction of banking (superelevation) on those spirals. These geometric limitations lower the maximum allowable speeds and detract from passenger comfort.

To investigate whether these curve-related problems could be resolved, the study team recalculated the geometrics of spirals and superelevation at every curve, and developed a contemplated program of curve realignments within the existing right-of-way. This detailed curve program is discussed in Appendix B.

- **Track structure.** As of 1997, the track components of the Keystone Corridor were found not to have been maintained to a “state of good repair.” Poor conditions at rail joints limited speeds at many locations to 70 mph; approximately one-third of the ties and switch timbers were judged to be defective; and special trackwork, such as switches (turnouts) and crossovers, had not been renovated in recent years. While Amtrak has worked since then to overcome the worst of these deficiencies, many speed restrictions remained in place as of 2000 and a comprehensive track renewal program was contemplated.

The posited improvements would include new wooden ties, continuous welded rail, track surfacing and ballast cleaning, and replacement and rehabilitation of turnouts.

- **Highway/railroad grade crossings.** With only three public, three private, and one pedestrian crossing, the Keystone Corridor is almost entirely grade-separated from the highway system. Moving to rid the Keystone Corridor of its last highway-railroad intersections, PennDOT in July 1999 obtained \$500,000 in special Federal high-speed rail grade crossing funds to design a grade separation and one bypass road that would eliminate the last three public crossings on the line.
- **Electrification.** Shared by the Keystone Corridor and the NEC main line, the Amtrak-owned portion of the former PRR electrification system consists of two basic parts:
  - A 25 cycle (Hz) power supply system, taking electricity from the utilities and converting it for use by the railroad. The power supply has exceeded its economic life; whether its escalating service disruption, maintenance, and repair costs are to be borne indefinitely, whether it is to be replaced in kind, or whether it is to be modernized to use 60 Hz commercial power, is unresolved.
  - The overhead catenary system, consisting of steel supports and wires that directly feed the trains, constitutes a major resource to the railroad, with many components that can be reused regardless of the resolution, if any, of the power supply question.

As the modernization-versus-replacement-in-kind decision remains unanswered for the bulk of the electric traction system from Washington to New York, this report omits any specific electrification program or cost estimate for the less visible but interconnected Keystone Corridor. However, the study assumes that, by the planning horizon year 2015, the power supply system between Philadelphia and Harrisburg will be so managed as to have no adverse impact on the reliability of train operations.

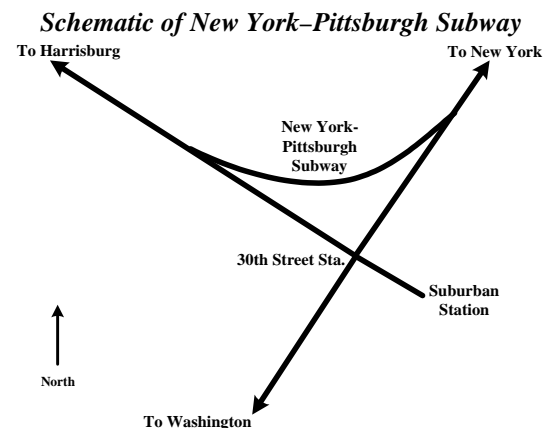
- **Signaling and train control.** Present signal system components for the most part are beyond their economic life—as much as 60 to 90 years old—and would need replacement or modification if they are to accommodate higher speeds, increased train operations, and prospective changes in the electric traction system. Furthermore, the seventeen interlockings (locations where trains may change from one track to another) in the Keystone Corridor are controlled from eight “towers” connected by voice communications, rather than from a centralized control center. In addition, although locomotives on the Keystone and Northeast corridors have an automatic train control feature that prevents the engineers from violating restrictive signals, the existing system does not automatically enforce speed limits due to curves, bridges, tunnels, and other line characteristics, nor does it enforce a positive stop at locations where conflicting routes can be established.

Therefore, this study contemplates a new hard-wired, track-circuit-based signal system for the Keystone Corridor that would extend the analogous system on the NEC main line. Accommodating top speeds of 110 mph, the signal system would have a positive stop/civil speed enforcement system identical to that proposed for the NEC. Finally, train control for the entire Keystone Corridor would be centralized in Philadelphia, and staffed towers would be eliminated.

- **Support facilities.** To accommodate the additional equipment, higher train frequencies, and new operating patterns, this study has postulated expanded equipment service and inspection facilities at Harrisburg.
- **Stations.** Harrisburg Station and Philadelphia's 30<sup>th</sup> Street Station underwent renovation in the 1980s and 1990s, respectively. Further renovations are being planned for Harrisburg. The study assumes that intermediate stations would be refurbished as necessary; that Amtrak and SEPTA will continue to work toward compliance with the Americans With Disabilities Act; that high-level platforms would be built at Paoli (in conjunction with a proposed new Transportation Center), Thorndale, and the new Harrisburg International Airport Station; and that parking facilities for intercity passengers would be added at most Amtrak stations. Other new stations that were under consideration as of 2000 were at Atglen (west of Parkesburg) and at Leaman Place (Paradise), east of Lancaster. The study did not address any modifications to Suburban Station, Philadelphia, that resumption of intercity service might necessitate.

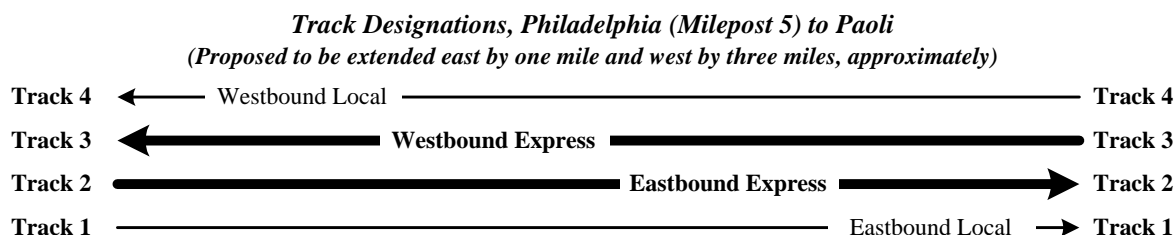
**Site-specific improvements.** If implemented, the site-specific proposals would primarily affect travel times and line capacity. Most of these projects would establish a high-speed path between Harrisburg and Philadelphia, provide additional operating flexibility in the event that the schedule goes awry, or simplify and downsize a fixed plant that no longer matches the operations it supports. Chapter 7 of the Main Report provides a detailed review of the contemplated site-specific improvements; key projects are summarized below.

- **Reactivate and upgrade an existing bypass of 30<sup>th</sup> Street Station for through Harrisburg–New York trains.** At Zoo Interlocking, north of 30<sup>th</sup> Street Station, a bypass exists—the New York–Pittsburgh Subway (“Subway”)—that would provide fast, direct service between New York and Harrisburg. Depicted in the schematic to the right, the grade-separated Subway would allow eastbound trains to divert



from the Keystone Corridor to the NEC without interfering with westbound Keystone Corridor trains. The Subway has been preliminarily found to require little if any structural rehabilitation, and would need only a track upgrade from 15 to 30 mph.

- **Allow high-speed intercity and faster commuter trains to take better advantage of the express tracks to the west of Zoo Interlocking.** Essentially, the Keystone Corridor is a four-track railroad between Philadelphia (to the west of Zoo) and Paoli. Faster trains use the center tracks (2 and 3), while local commuter services use the local tracks (1 and 4). (See the figure below.) Currently, westbound express trains



must change tracks repeatedly through Zoo Interlocking to access the center track 3, and eastbound expresses must do the same to get from center track 2 to track 1 and 30th Street Station’s Upper Level. Each time a high-speed train changes tracks, it loses about a minute and a half <sup>12</sup> because diverging moves are normally much slower than straight-through moves. By restoring and extending Track 3 through the Zoo Interlocking area, and by creating an eastbound high-speed connection from Track 2 to Track 1, the contemplated improvements would establish a higher-speed path between 30th Street Station’s Upper Level, Zoo Interlocking, and points west.

- **Similarly, revise the western end of four-track territory to eliminate diverging moves for high-speed trains.** At present, the center, “express” tracks 2 and 3 dead-end just west of Paoli; westbound express trains need to make diverging moves at Paoli Interlocking to serve Paoli Station (which has platforms on the local tracks only), and eastbound trains need to divert, slowly, east of Paoli to track 2.

Under the contemplated program, two new center-island, high-level passenger platforms at Paoli—between tracks 1 and 2, and between tracks 3 and 4—would eliminate the present need for time-consuming diversions there, and would expedite passenger transfers between local and express trains in both directions. Paoli Interlocking would be eliminated. West of Paoli, trackage and interlockings would be revamped to provide a straight-through move for both east- and westbound trains. These improvements would, in short, move the transition between two- and four-track territory approximately three miles west from Paoli to the Frazer vicinity, and would eliminate the diverging moves now associated with that transition.

- **Provide straight-through moves for high-speed trains at Lancaster and Harrisburg.** In order to stop at the Lancaster or Harrisburg station platforms,

Amtrak's Keystone Corridor trains today must make painfully slow diverging moves through complex, superfluous trackage. The contemplated improvements include a redesign and simplification of the track layout at both these important cities so as to gain travel time advantages.

- **Omit needless trackage.** The study has identified several areas that are overbuilt for present needs. Examples include the third and fourth tracks between Glen and Park Interlockings; the interlockings at Caln and Park; and the many unused freight tracks at Thorn Interlocking. These currently superfluous facilities relate to former PRR freight services that Conrail diverted to other lines. Meanwhile, in the wake of the recent acquisition and division of Conrail by CSX and Norfolk Southern (NS), Amtrak and NS are considering—but have not agreed upon—the resumption of through freight traffic over the Keystone Corridor. The plans and cost estimates in this report assume that through freight traffic will not reappear, thus permitting the elimination of currently excess freight trackage, reducing maintenance expenses, and simplifying operations. To the extent that the NS resumes freight operating patterns analogous to those of the PRR, the program contemplated in this monograph would require amendment.
- **Provide additional facilities where needed to support commuter service.** The potential improvements would include a number of commuter-related projects, for example:
  - Improved access to and from the SEPTA yard at Frazer;
  - At Thorndale, a “tail track” where commuter trains can turn without encumbering the main tracks;
  - An interlocking and “tail track” at Atglen, which would allow SEPTA’s projected long-distance commuter trains to turn without interfering with Amtrak services;
  - At Harrisburg International Airport, an interlocking and “tail track” to support shuttle trains to and from Harrisburg, as well as a new station with high-level platforms.
  - At Harrisburg, two new station tracks and a new high-level platform to accommodate the proposed airport shuttles and Carlisle and Lancaster commuter services.
- **Upgrade interlockings with higher-speed crossovers.** Wherever possible, the contemplated program would replace low-speed crossovers (for example, with 30 mph limits for diverging moves) with higher-speed crossovers (with 45 mph diverging limits).
- **Add interlockings where excessive gaps exist.** Although the Keystone Corridor has several interlockings that deserve elimination, other portions of the route lack places where trains can change tracks. For example, a 22-mile stretch without interlockings would exist between Atglen (milepost 46) and Lancaster (milepost 68); a contemplated new interlocking at Leaman Place (Paradise—milepost 56) would

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<sup>12</sup> Of course, precise time losses vary by location.

bisect this stretch. Similarly, a new interlocking at Mount Joy (milepost 80) would relieve a similar gap between Lancaster (milepost 69) and Roy Interlocking (milepost 94).

## PROGRAM COSTS

For the information of both the public and any potential partners in Keystone Corridor betterments, the table on page ES-10 summarizes relevant cost data. If such organizations as PennDOT, SEPTA, NS, Amtrak, or other public and private entities, should wish to pursue betterments of the types contemplated in this monograph, they would need to address—in addition to the obvious cost and funding challenges—the prioritization of any project elements. Entering into such prioritization discussions could be considerations akin to the following:

- **Beneficiaries**—the types of services, and the number of passengers, that will gain from each improvement. For example, improvements that would benefit both commuter and Amtrak services, or that would create travel time savings for a large number of rail travelers, may have a higher call upon funding than betterments that would assist only one service or only a few riders.
- **Performance projections.** For many travel-time-related improvements, there would be ways to calculate the minutes saved per dollar spent, thus yielding a priority order for this limited group of projects. Such other useful measures as return on investment can be applied to a wide range of project types.
- **Urgency.** Improvements that address high-priority safety and reliability concerns—for example, grade crossing eliminations and the short-term preservation of the signaling and electric traction systems—may acquire precedence over time-saving projects.
- **Staging of service improvements.** The proposed 90-minute Harrisburg–Philadelphia timing, while an achievable goal, is not a prerequisite to the implementation of perceptible Keystone Corridor service improvements. Intermediate upgrades—including the use of electric-powered equipment (if readily available to and allocable by Amtrak), direct through trains between Harrisburg and New York, and service to Center City Philadelphia—could represent tangible progress to the traveling public and might be achieved sooner than the 90-minute timing, should the Commonwealth of Pennsylvania wish to foster their implementation.

These factors merely exemplify the prioritization techniques that any public and private partners may employ in considering their future options in the Keystone Corridor.

## Potential Improvements to the Keystone Corridor

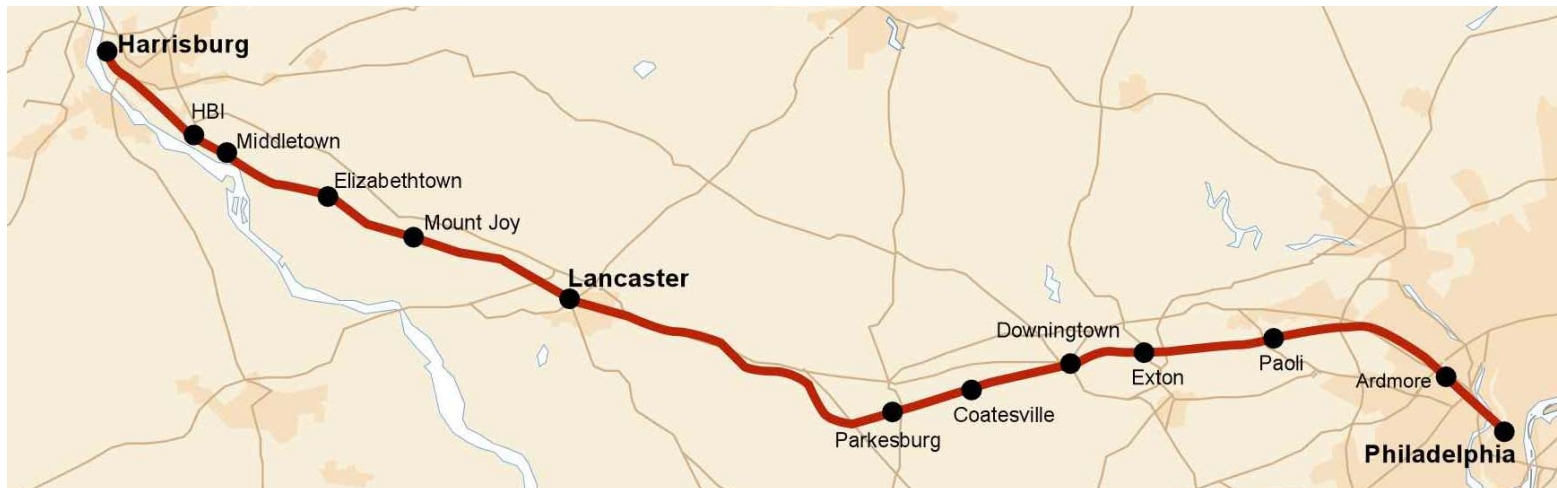
|  | Principal Objectives Served |          |                               | Total Cost<br>(Millions of 1998<br>Dollars) |
|--|-----------------------------|----------|-------------------------------|---|
|  | Trip Time                   | Capacity | Recapitalization<br>and Other |   |
| <b>Corridor-Wide Investments</b>   |                             |          |                               |   |
| Curve Realignment  | •                           |          |                               | \$57  |
| Track Quality  | •                           |          | •                             | \$100                                       |
| Bridges, Culverts, Other Structures  |                             |          | •                             | \$15  |
| Electrification (Replacement of worn catenary wire within commuter territory. Does not address comprehensive rehabilitation or replacement of the electric traction system.) |                             |          | •                             | \$20  |
| Signalling and Train Control   | •                           | •        | •                             | \$199                                       |
| Stations and Parking   |                             | •        | •                             | not estimated                               |
| Operational Changes  | •                           | •        | •                             | not a capital cost item                     |
| <i>Total for Corridor-Wide Investments (exclusive of items not estimated)</i>  |                             |          |                               | \$391                                       |
| <b>Site-Specific Investments</b>   |                             |          |                               |   |
| Philadelphia Passenger Terminal Area through Overbrook Interlocking—Reconfiguration  | •                           | •        | •                             | \$60  |
| Bryn Mawr Interlocking Reconfiguration   |                             | •        |                               | \$9   |
| Relocate Paoli Station; Track and Interlocking Changes, Paoli through White and Frazer   | •                           | •        | •                             | \$63  |
| Glen Interlocking Reconfiguration  |                             |          |                               | \$9   |
| Track Rationalization, Caln to Caln (Includes Removal of Downs Interlocking)   |                             |          | •                             | \$6   |
| Thorndale Station Redevelopment; Thorn and Caln Interlocking Reconfigurations  |                             | •        | •                             | \$26  |
| Track Rationalization, Caln to Park (Includes Removal of Park Interlocking); Atglen Station and Interlocking   |                             | •        | •                             | \$15  |
| Leaman Place (Paradise): New Interlocking and Station  |                             | •        | •                             | \$12  |
| Lancaster Reconfiguration  | •                           |          | •                             | \$11  |
| Operational Flexibility, Lancaster– Harrisburg (Roy and Mt. Joy Interlockings; Middletown Eastbound Platform.)   |                             | •        |                               | \$25  |
| Airport Station  |                             |          | •                             | \$9   |
| Equipment support facilities at Harrisburg   |                             |          |                               | \$10  |
| Harrisburg Reconfiguration   | •                           | •        | •                             | \$42  |
| <i>Total for Site-Specific Investments (exclusive of items not estimated)</i>  |                             |          |                               | <b>\$295</b>                                |
| <b>Grand Total, Potential Keystone Corridor Improvements</b><br>(exclusive of items not estimated and rolling stock)   |                             |          |                               | \$686                                       |

## IN CONCLUSION . . .

Reliable fulfillment of a 90-minute trip time goal between Center City Philadelphia and Harrisburg would depend on a number of system-wide and site-specific improvements. In describing those improvements, this technical monograph is intended to provide potentially interested entities with a factual basis for considering the merit and desirability of their possible future participation in betterments to the Keystone Corridor. In addition, for the use of States and localities outside Southeastern Pennsylvania, this monograph provides examples of the

technical challenges and potential solutions to development of mature railroad corridors in heavily populated areas.

# **Technical Monograph: Transportation Planning for the Philadelphia–Harrisburg “Keystone” Railroad Corridor**



**Federal Railroad Administration  
United States Department of Transportation**

**March 2004**

# **Chapter 1**

## **INTRODUCTION**

This technical monograph describes a set of potential long-term improvements to the Keystone Corridor, a mature, high-volume passenger railroad linking Philadelphia and Harrisburg, Pennsylvania. The monograph discusses the origin and purpose of the underlying studies; the corridor's current<sup>13</sup> condition and usage; its assumed transportation role in the 21<sup>st</sup> Century; and a set of possible improvements—both corridor-wide and site-specific—that would allow the Keystone Corridor to provide enhanced intercity and commuter train services, should the Commonwealth of Pennsylvania elect to foster such upgraded operations.

### **BACKGROUND OF THE STUDY**

The 1996 Appropriations Act for the Department of Transportation and related agencies requires that “the Federal Railroad Administration (FRA) and Amtrak provide . . . a joint and comprehensive transportation plan (CTP) for the Washington, D.C. to New York, N.Y. segment of the corridor that details (1) the state of the rail line, (2) all required capital improvements, (3) necessary improvements and recapitalization, and (4) a projected time line for these expenditures over the next two decades. This plan should include information on how the costs for upgrading and maintaining the railroad will be shared by all users of the rail line.”

As work on the CTP progressed, FRA and Amtrak decided to analyze the Keystone Corridor in support of the CTP, for the following reasons:

- The Keystone Corridor shares complex facilities, and exchanges through passengers, with the Northeast Corridor (NEC) main line at Philadelphia. Indeed, certain trains use both corridors. Thus, tight operating, marketing, and physical linkages exist between the two routes, both of which Amtrak owns. These close connections mirror the shared history of these railroads, which developed into the most advanced passenger lines in the Nation under the auspices of the Pennsylvania Railroad (PRR), whose main line they constituted from the 19<sup>th</sup> Century until 1968. All these factors create a strong synergy between analyses of the two corridors.
- Section 1103(c) of the TEA-21 legislation<sup>14</sup> recognized the importance of the Keystone Corridor by designating it as one of ten potential high-speed rail corridors<sup>15</sup> that are eligible for specialized funds for the improvement of highway-rail grade crossings. Similarly, the Commonwealth of Pennsylvania has

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<sup>13</sup> I.e., during the late 1990s, in which period the analysis took place.

<sup>14</sup> Transportation Equity Act for the 21<sup>st</sup> Century, enacted June 9, 1998 as Public Law 105-178.

<sup>15</sup> For a chronology of corridor designations, see FRA's web site at <http://www.fra.dot.gov/Content3.asp?P=618>.

studied the Keystone route intensively, with some analyses covering the entire railroad between Philadelphia, Harrisburg, and Pittsburgh. On October 11, 2000, in response to a State application, the U.S. Secretary of Transportation extended the high-speed corridor designation from Harrisburg west to Pittsburgh. **The term “Keystone Corridor” in this report consistently refers to the Philadelphia–Harrisburg line only.**

- In recent years, the Commonwealth of Pennsylvania and Amtrak have undertaken some joint initiatives to invest in the line.<sup>16</sup> Information on potential longer-term betterments, such as this monograph discusses, would provide useful background should Pennsylvania and Amtrak elect to consider options for, and costs and benefits of, near-term investment opportunities.

Thus, operational connections, analytical synergy, transportation history, and some recent activity on the part of Pennsylvania and Amtrak converged to motivate research into the Keystone Corridor in support of the CTP.

## PURPOSE AND APPROACH

This monograph aims at specifying, on a preliminary basis, a set of potential infrastructure improvements that could enable the Keystone Corridor to accommodate reliably the quality, mix, and volume of intercity passenger, commuter, and freight services that the line’s operators and State and regional public partners envision for the year 2015.

In view of the multiple uses of the Keystone Corridor, proper performance of the study necessitated a team effort, in which FRA, Amtrak, the Pennsylvania Department of Transportation (PennDOT), and the Southeastern Pennsylvania Transportation Authority (SEPTA) participated. Input from the freight railroad operators (Conrail and its successor, Norfolk Southern (NS)) was also sought; however, as the research took place just as freight service was making a challenging transition from Conrail to NS management, authoritative projections for NS operations affecting the Keystone Corridor were not available. Since the Keystone Corridor has long been an overwhelmingly passenger-oriented railroad, the lack of freight projections should not materially detract from the overall validity and usefulness of this monograph.

The study is based on the following comprehensive analytical approach:

- Assess current facilities, services and operating conditions on the route;

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<sup>16</sup> As of 1999, Amtrak and PennDOT were intending to invest approximately \$140 million in the Keystone Corridor, to be allocated proportionately as follows:

|   |     |
|---|-----|
| <b>Equipment:</b> Electric locomotives and upgraded passenger cars                  | 32% |
| <b>Track Structures:</b> Replace old wooden ties and install continuous welded rail | 30% |
| <b>Signals:</b> Upgrade the signal system   | 15% |
| <b>Electric Traction:</b> Rehabilitate the overhead electric power system           | 11% |
| <b>Bridge Repairs</b>   | 8%  |
| <b>Station Construction</b>   | 4%  |

- Characterize service needs and desires, on the part of the operators and State and regional sponsors, for the planning year 2015;
- Conduct operational analyses regarding the performance of future (year 2015) services over various configurations of infrastructure; and
- Identify the infrastructure investments that could—if implemented under the aegis of the Commonwealth of Pennsylvania with Amtrak’s participation—allow the Corridor’s operators and sponsors to achieve their intended 2015 service quality and train volumes with satisfactory reliability.

The following chapters address each of these tasks. Further particulars on methodology appear in Chapter 4.

## Chapter 2

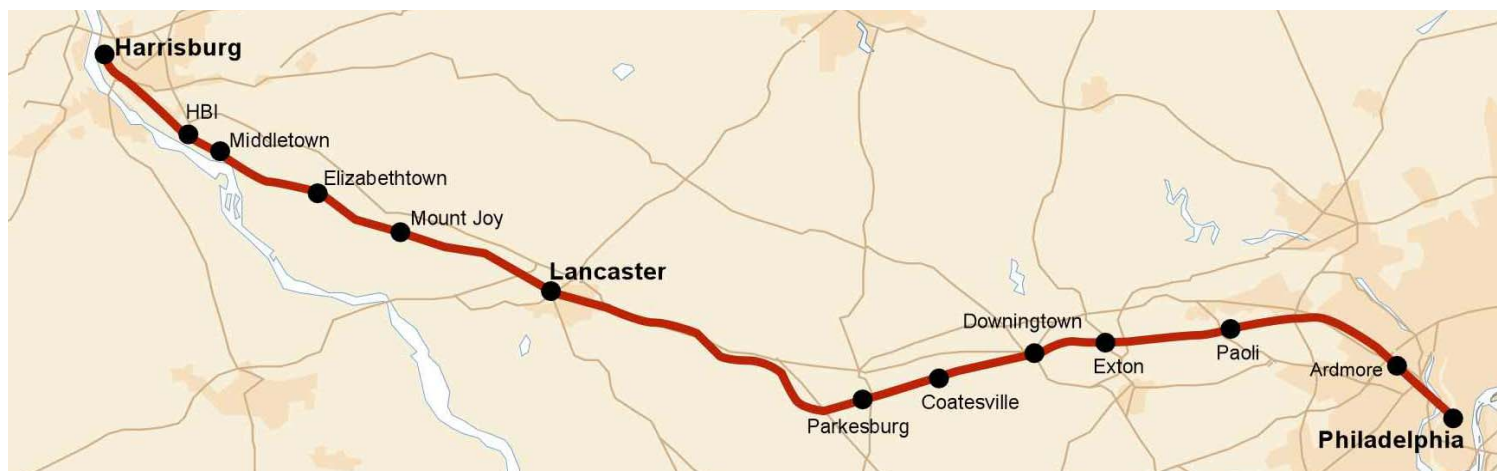
# THE CORRIDOR TODAY

### FIXED PLANT

#### Location

The Keystone Corridor (Figure 2-1), 104 miles in length, links Philadelphia and Harrisburg, Pennsylvania, over the Main Line of the former PRR. The Keystone Corridor connects with the NEC in Philadelphia.

**Figure 2-1**  
**Map of Keystone Corridor**



#### Background and Ownership

Dating back to the 1830s and serving, for almost a century and a half, as the kernel of the PRR—perhaps the world’s foremost railroad company in its heyday—the Keystone Corridor has a thoroughly-documented history.<sup>17</sup> In 1968, the Keystone Corridor became part of the Penn Central Transportation Company; in a major restructuring of Northeast and Midwest railroads in 1976, ownership and full operating control of the Keystone Corridor was transferred to Amtrak, although Conrail retained trackage rights for freight. On June 1, 1999, Conrail’s remaining freight responsibilities, described further below, devolved to the Norfolk Southern (NS).

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<sup>17</sup> See George H. Burgess and Miles C. Kennedy, *Centennial History of the Pennsylvania Railroad Company—1846-1946*, New York: Arno Press, 1976 (reprint of original 1949 edition). More recently, there is David W. Messer, *Triumph II, Philadelphia to Harrisburg 1828-1998*, Barnard, Roberts & Co., Inc., June 1999. Also, an exhaustive chronology of the PRR’s history can be found at [http://www.prrths.com/PRR\\_hagley\\_intro.htm](http://www.prrths.com/PRR_hagley_intro.htm).

## **Data Sources**

The following summary of existing infrastructure conditions is based on the “State of Good Repair” report prepared by Amtrak in 1995, as well as work previously performed for PennDOT, limited field investigations performed early in 1997,<sup>18</sup> and Amtrak Track Program production reports for 1997 through 1999.

## **Trackage and Track Conditions**

The line has four tracks between Philadelphia and Paoli, two and three tracks between Paoli and Parkesburg, and two tracks between Parkesburg and Harrisburg.

In general, as of early 1997, the study team found that the Keystone Corridor had **not** been maintained to a “state of good repair”: considerable deferred maintenance was found to have accumulated, thus preventing the line from operating at the relatively high performance level to which it was designed. In response to these conditions Amtrak initiated a Keystone Improvement Program in 1997. The first four years concentrated on wood tie replacements; a rail replacement program was initiated in 2000. Tie and rail replacement programs continue. Numerous speed restrictions have been removed and Amtrak, working in conjunction with PennDOT, has made progress toward restoring the line to a state of good repair.<sup>19</sup> This finding reflects the status of the following track components.

### ***Rail***

Prior to 2000, a review of the line indicated that over 55 percent of the existing track is comprised of continuous welded rail (CWR) and is rated at 90 mph.<sup>20</sup> The balance is in jointed rail, on which Amtrak limits maximum speed to 70 mph. The poor condition of the joints—battered and in many instances not supported by sound ties—contributes to the relatively poor ride quality in the Keystone Corridor and enters into the 70 mph speed restriction. Reports of inspections for internal defects indicate that the existing rail is sound. Most of the existing jointed rail consists of 130-lb., 131-lb., 152-lb., and 155-lb. rail sections, which have not been rolled since the late 1950s.

### ***Ties and Timbers***

The tie condition along the Keystone Corridor was poor in 1997. An intensive tie renewal program was initiated in 1997 to overcome this aspect of deferred maintenance. Approximately 185,000 ties were installed during the first three years.

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<sup>18</sup> Amtrak’s “State of Good Repair” analysis received support from Parsons Brinckerhoff. For the PennDOT work, cf. PennDOT, *Keystone Corridor Assessment and Business Plan, Draft Report*, May 10, 1996, by R. L. Banks & Associates, Inc.

<sup>19</sup> This paragraph reflects conditions at the end of the study period—in 2000.

<sup>20</sup> Some of the welded rail is “fit”: it was previously removed from track, its ends were cut off (cropped), and it was welded into 1400-foot strings. Therefore, some of the welded rail initially could have been installed 50 to 60 years ago, and would not be suitable for high-speed tilt-train operations.

Switch timbers also were found to be in relatively poor condition, necessitating extensive timber renewal: PennDOT's *Keystone Corridor Assessment* estimated<sup>21</sup> that at least a 33 percent renewal would be needed. Limited renewals have occurred over the last four years.

### ***Turnouts, Crossovers, and Double-Slip Switches***

Turnouts, crossovers, and double-slip switches, which are used to divert trains to another track or to cross over between two tracks, have an average life of between 25 and 30 years depending on train density and maintenance levels. Significant renewals of these special trackwork items have not taken place in recent years in the Keystone Corridor. Individual components have been replaced, as necessary, but replacements using modern techniques, such as switch replacement machines that remove the old turnout (rail and timbers) and install new turnouts in panels that are complete with timbers, have been minimal.

### ***Ballast and Subgrade***

Ballast appears to be in good condition, and with some minor exceptions, drainage is adequate.

### ***Geometry of the Permanent Way***

Recent investigations have found the "line" and "surface" to be generally satisfactory when the substandard tie conditions are taken into account. ("Line" is trueness of horizontal alignment; "surface" is levelness of vertical profile.) However, a detailed analysis of the existing curves, documented in Appendix B, indicated that the curves have relatively poor geometric characteristics. In particular, the actual superelevation or "banking" of curves<sup>22</sup> on the Harrisburg line, as ascertained in field investigations, does not agree with today's recommended practices of railway engineering. Specifically:

| <b>Type of Location</b>   | <b>Recommended Practice</b>  | <b>Actual Condition of Keystone Corridor</b>                            |
|---|--|---|
| Tangent (straight) track  | No superelevation whatsoever   | Superelevation is introduced on tangent track                           |
| Spirals (transition sections between straight and curved track) | Superelevation is to be gradually introduced in accordance with formulas | Amounts of superelevation do not agree with generally accepted formulas |
| Body of curves (constant degree of curvature)                   | Superelevation is to be constant   | Superelevation changes  |

<sup>21</sup>PennDOT, op. cit., page 36.

<sup>22</sup> I.e., the intentional difference in elevation between the high and low rail on a curve, introduced to permit higher speeds with acceptable levels of passenger comfort.

These divergences from recommended practice degrade the ride quality and tend to hold down the speed limits on the Keystone Corridor.

## ***Clearances***

Freight traffic between Harrisburg and New Jersey historically used the Trenton Cutoff, which diverges from the Keystone Corridor at Glen Interlocking (MP 25.5). For this reason, existing freight clearances in the Keystone Corridor vary east and west of Glen.

**Vertical Clearances.** The maximum vertical clearance between Harrisburg and Glen is 17 feet 2 inches; east of Glen, the maximum allowable vertical is 15 feet 6 inches (technically known as “Plate C”).

**Horizontal Clearances.** A wide load clearance of 12 feet 0 inches exists between Glen and Coatesville. Chapter Six

contains a discussion of the specialized issues related to clearances for wide loads at stations with high-level platforms.

### **BRIDGES, CULVERTS, AND OTHER STRUCTURES ON THE KEYSTONE CORRIDOR**

- 41 steel undergrade bridges
- 37 concrete undergrade bridges
- 51 stone undergrade bridges
- 60 brick undergrade bridges
- 1 timber undergrade bridge
- 1 tunnel (see footnote 19)
- 183 culverts
- 57 signal structures
- 39 retaining walls
- Over 50,000 linear feet of fences.

There are no movable bridges in the Keystone Corridor.

### **Bridges, Culverts, and Other Structures**

An inventory of bridges, culverts, and related structures appears in the list to the left.

Amtrak’s Engineering Department routinely inspects the Keystone Corridor’s railroad bridges and programs the most urgent repairs for short-term completion. The scope of this study did not include such intensive engineering and economic investigations<sup>23</sup> as would provide conclusive short-term evaluations or long-term forecasts of

bridge conditions in the Keystone Corridor and establish a continuing, cost-effective program for their maintenance, repair, and any needed replacement. However, a limited survey of bridge conditions has suggested that although age and deferred maintenance have occasioned some deterioration, most of the bridges appear to be in reasonable condition, subject to the above-mentioned limitations of this study’s scope. While this limited survey identified no bridges requiring immediate replacement, more intensive investigations may

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<sup>23</sup> Such intensive work would have far exceeded the study budget.

point to some structures whose replacement would be more economic than the cost of rehabilitation. An allowance for bridge work is included in the cost estimates (see page 6-4 and Table 8-1).

There are no movable bridges or tunnels<sup>24</sup> in the Keystone Corridor. Neither culverts nor retaining walls surveyed exhibited any obvious, urgent defects in the course of this limited study or in Amtrak's prior work; however, some deterioration has occurred.

## **Highway-Railroad Grade Crossings**

Fortunately, the Keystone Corridor has an unusually small number of grade crossings, including three public, three private, and one pedestrian crossing. All are reported to be in acceptable condition, with the exception of Eby–Cheques Road, which is worn from heavy truck traffic. Aggressively moving to rid the Keystone Corridor of its remaining highway-railroad intersections, PennDOT in July 1999 obtained \$500,000 in special Federal high-speed rail grade crossing funds to design a grade separation and one bypass road that would eliminate the last three public crossings on the line.

## **Electrification**

Although the Keystone Corridor is North America's only electrified intercity rail passenger corridor outside the NEC main line, the system dates back to the 1915–1938 era. The overhead catenary system (the wires and supports that directly feed trains) remains a valuable resource to the railroad; however, the substations and power supply facilities—while functional—have outlived their economic life. Chapter 6 presents more details on the issues surrounding the Keystone Corridor's electrification and its future.

## **Signals, Train Control, and Communications**

### ***Signaling and Train Control***

With but a few exceptions, the signal system is obsolete, dating at least as far back as the installation of electrification in 1915 and 1938. Frequent local cable failures cause train delays and general unreliability. Track circuits employing centrifugal relays are found at a number of locations. The centrifugal relays in the Keystone Corridor have now been in service for a minimum of 60 years; those on the segment from Paoli to Zoo date back to 1915. All are well beyond their design life. Although originally made to the highest standards of quality, they have been subject to wear and frequent failure due to their complexity, and are expensive to inspect and repair.

Much of the signal equipment is costly to maintain and some needed parts are difficult to obtain. Performing the required tests is labor intensive. At some locations,

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<sup>24</sup> A minor exception is the Gallagherville Tunnel (MP 33.8), which is a “jumpover” (i.e., a grade-separated junction between the Main Line and a diverging track—the railroad equivalent of a “stacked” freeway interchange) constructed as a brick-lined, stone-faced arch.

particularly Thorn, Park, and State interlockings, an excessively large plant remains for freight operations that are no longer performed; this inflates maintenance needs and expenses. At various locations, air compressors and air lines, signal express cables, switch cables, and switch heater cables need to be renewed.

Exceptions to the prevailing deteriorated conditions are as follows:

- New interlockings have been placed in service at Stiles, Paxon, and Woodbine (all between Mileposts 3 and 5, and all remote controlled from Zoo Interlocking) in conjunction with the construction of the SEPTA Overbrook Maintenance Facility.<sup>25</sup>
- The control system at Bryn Mawr (Milepost 10) has been largely rebuilt after a fire damaged the interlocking plant beyond repair. Bryn Mawr is now remotely controlled from Paoli.
- Until 1996, the recently-built Frazer maintenance facility was not accessible from the east (Paoli and Philadelphia). Access was available only from the west, via the Dale Secondary from Glen Interlocking. Effective June 1, 1996, Frazer Interlocking was placed in service (between Mileposts 23 and 24), providing access to the east end of the shop and a turnback track.

The intermediate signals<sup>26</sup> are obsolete, but have been maintained to a reasonable level of repair. Most of the intermediate signals date from the electrification in the mid-1930s; however, those between Overbrook and Paoli were installed in 1915. West of Paoli, the signal express cable is carried on a separate set of wayside wood poles, many of which are rotted at the base; these should be replaced with a subsurface line.

An automatic train control system—an early-20<sup>th</sup> century precursor of today's positive train control systems—is in place on this line, satisfying Federal safety code provisions for operation over 79 mph that apply to this long-established high-performance railroad.<sup>27</sup>

### ***Operational Control and Dispatching***

Amtrak owns and exerts operating control over both the Keystone Corridor and the connecting 226-mile NEC line (“NEC South”) between New York, Philadelphia, and Washington.

The heart of the NEC South/Keystone system is Amtrak's Centralized Electrification and Traffic Control (CETC) Center in Philadelphia.<sup>28</sup> Amtrak uses completely separate control systems for the NEC South and Keystone corridors. From the CETC Center, NEC

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<sup>25</sup> See under “Support Facilities,” below.

<sup>26</sup> I.e., between interlockings.

<sup>27</sup> Existing speed restrictions over much of the line reflect track conditions, alignment limitations, and other factors.

<sup>28</sup> The CETC center in Philadelphia actually controls the NEC main line from Holmesburg Junction (between Trenton and Philadelphia) to Washington, D.C. Pennsylvania Station, New York City, fulfills an similar function for the territory north of Holmesburg Junction.

South trains are electronically dispatched and interlocking switches are remotely controlled. By contrast, although the dispatching desk for the Keystone Corridor is co-located with the NEC South control system in the CETC Center, the Keystone Route relies primarily on a manual operating system. Of the 17 interlockings, eight are controlled on-site by block operators at interlocking stations or “towers”; seven are remotely controlled from other towers, as shown in Table 2-1. The dispatcher at the CETC Center communicates with the tower operators by telephone, to control train movements between Philadelphia and Harrisburg in the traditional manner. Except for Bryn Mawr (mentioned above) and Parkesburg (now closed), all the staffed towers existing at the time of the 1968 Penn Central merger continue in operation.

**Table 2-1: Interlockings on the Keystone Corridor<sup>29</sup>**

| <b>Interlocking Name</b> | <b>Milepost</b> | <b>Remotely Controlled From—</b> |
|--------------------------|-----------------|----------------------------------|
| Zoo                      | 1.9             |                                  |
| Stiles                   | 3.5             | Zoo                              |
| Valley                   | 4.0             | Overbrook                        |
| Paxon                    | 4.1             | Zoo                              |
| Woodbine                 | 5.1             | Zoo                              |
| Overbrook                | 5.4             |                                  |
| Bryn Mawr                | 10.1            | Paoli                            |
| Paoli                    | 19.9            |                                  |
| Frazer                   | 23.9            | Thorn                            |
| Glen                     | 25.3            | Thorn                            |
| Downs                    | 32.1            | Thorn                            |
| Thorn                    | 35.0            |                                  |
| Caln                     | 36.6            | Thorn                            |
| Park                     | 43.9            |                                  |
| Cork (Lancaster)         | 68.1            |                                  |
| Roy                      | 94.5            |                                  |
| State (Harrisburg)       | 104             |                                  |

The telephone system used by the dispatcher to communicate with tower operators relies on duct line cable east of Paoli, and aerial cable to the west. These older communications facilities have far exceeded their service lives and need constant maintenance. Recently, T-1 phone lines were leased to improve communications between the dispatcher and tower operators. Supplementing the telephone system is a radio system that allows direct communication between dispatchers, operators, and train crews.

<sup>29</sup> Source: Amtrak operating timetable.

## **Support Facilities**

Amtrak bases its Keystone Service fleet at Penn Coach Yard and Race Street Engine House, within the 30th Street Station complex. Only light cleaning and minor inspection occur at Harrisburg. Heavy repairs and overhauls are performed at other facilities, such as Wilmington and Beech Grove.

SEPTA has built a new maintenance facility for its fleet of electric multiple-unit (“MU”) cars<sup>30</sup> at Overbrook, an area once occupied by the 52nd Street freight yard. Also, in connection with the purchase of locomotives and non-powered coaches and cab cars for push-pull service<sup>31</sup> from Bombardier, SEPTA built a maintenance facility at Frazer. The Overbrook and Frazer facilities have assumed all of the maintenance operations (and their equivalents for non-MU equipment) formerly performed at Paoli.

## **Stations and Parking**

Table 2-2 displays the location, ownership, and user(s) of the Keystone Corridor stations.

With the exception of Paoli, SEPTA leases and operates all stations from Overbrook to Downingtown. These include an assortment of structures of varying ages and conditions, with most constructed in the 19th century. SEPTA has renovated some of the stations under its care, and plans to renovate more. A major project is planned for Overbrook, including renovation of the station and provision of additional parking. Station renovations at Radnor, Wayne, Strafford, and Downingtown also are planned or underway.

Amtrak operates the station at Paoli, providing space for a SEPTA ticket office, and all stations west of Downingtown. Amtrak stations range from the simplest, with only a short platform and a bus stop-type waiting shelter on each side, to major facilities at Harrisburg and Lancaster. The Harrisburg station, which is on the National Register of Historic Places, was initially constructed in the late 19th century and was completely renovated in 1986. Aesthetically the station appears to be in very good condition, although some improvements are required in the near term. By contrast, the Paoli station—an austere, serviceable brick box of post-World War II construction—needs substantial cleaning and repair. Tentative plans call for construction of a new station to the west, with better facilities and expanded parking, which would open the existing site to new development.

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<sup>30</sup> Multiple Unit cars are self-propelled rail passenger cars (usually in commuter service) that can be coupled into groups and operated by a single person from a control cab in the leading car.

<sup>31</sup> Push-pull equipment has a control cab in the car at the opposite end of the train from the locomotive, for bi-directional operation.

**Table 2-2: Station Ownership and Use**

| Milepost <sup>32</sup> | Location                     | User                           | Owner                |
|------------------------|------------------------------|--------------------------------|----------------------|
| 0.0                    | Philadelphia (Suburban Sta.) | SEPTA <sup>33</sup>            | SEPTA                |
| 1.0                    | Philadelphia (30th St.)      | Amtrak/SEPTA/NJT <sup>34</sup> | Amtrak               |
| 5.4                    | Overbrook                    | SEPTA                          | Amtrak <sup>35</sup> |
| 6.0                    | Merion                       | SEPTA                          | Amtrak               |
| 9.8                    | Narberth                     | SEPTA                          | Amtrak               |
| 7.5                    | Wynnewood                    | SEPTA                          | Amtrak               |
| 8.5                    | Ardmore                      | Amtrak/SEPTA                   | Amtrak               |
| 9.1                    | Haverford                    | SEPTA                          | Amtrak               |
| 10.1                   | Bryn Mawr                    | SEPTA                          | Amtrak               |
| 10.9                   | Rosemont                     | SEPTA                          | Amtrak               |
| 12.0                   | Villanova                    | SEPTA                          | Amtrak               |
| 13.0                   | Radnor                       | SEPTA                          | Amtrak               |
| 13.8                   | St. Davids                   | SEPTA                          | Amtrak               |
| 14.5                   | Wayne                        | SEPTA                          | Amtrak               |
| 15.4                   | Strafford                    | SEPTA                          | Amtrak               |
| 16.5                   | Devon                        | SEPTA                          | Amtrak               |
| 17.5                   | Berwyn                       | SEPTA                          | Amtrak               |
| 18.6                   | Daylesford                   | SEPTA                          | Amtrak               |
| 19.9                   | Paoli                        | Amtrak/SEPTA                   | Amtrak               |
| 21.6                   | Malvern                      | Amtrak <sup>36</sup> /SEPTA    | Amtrak               |
| 27.5                   | Exton                        | Amtrak/SEPTA                   | Amtrak               |
| 28.3                   | Whitford                     | Amtrak/SEPTA                   | Amtrak               |
| 32.4                   | Downingtown                  | Amtrak/SEPTA                   | Amtrak               |
| 35.5                   | Thorndale                    | SEPTA <sup>37</sup>            | Amtrak <sup>38</sup> |
| 38.4                   | Coatesville                  | Amtrak                         | Amtrak               |
| 44.2                   | Parkesburg                   | Amtrak                         | Amtrak               |
| 68.0                   | Lancaster                    | Amtrak                         | Amtrak               |
| 80.1                   | Mount Joy                    | Amtrak                         | Amtrak               |
| 86.8                   | Elizabethtown                | Amtrak                         | Amtrak               |
| 94.7                   | Middletown                   | Amtrak                         | Amtrak               |
| 104.6                  | Harrisburg                   | Amtrak                         | Amtrak <sup>39</sup> |

<sup>32</sup> All mileposts are measured from Suburban Station, Philadelphia.

<sup>33</sup> Not currently used for Amtrak service. However, this was the customary terminus for Harrisburg–Philadelphia trains prior to recent Amtrak service modifications. Unique among American cities in the multiplicity and flexibility of its downtown rail passenger stations, Philadelphia affords several options for establishing the eastern endpoint of the Keystone Corridor, and the inclusion of Suburban Station in this table is without prejudice to such a future choice.

<sup>34</sup> New Jersey Transit (for Atlantic City commuter service)

<sup>35</sup> Leased to SEPTA

<sup>36</sup> Amtrak withdrew service in 1998.

<sup>37</sup> Station entered service on November 21, 1999.

<sup>38</sup> The recently-built 460-space parking facility at Thorndale is SEPTA-owned.

<sup>39</sup> Leased to Harrisburg Redevelopment Authority; parts of the station are leased back to Amtrak for passenger service.

Significant parking facilities are available at Ardmore, Bryn Mawr, Paoli, Malvern, Exton, Downingtown, and Thorndale. Limited parking is available at other stations. Almost 1,200 parking spaces have been added at 11 stations since 1987.

## USERS AND SERVICES

### Entities

Several entities exercise ownership, operating, and service sponsorship responsibilities on the Keystone Corridor, as analyzed in Table 2-3.

**Table 2-3: Entities and Their Roles in the Keystone Corridor**

| Entity  | Functions   |
|---|---|
| Amtrak  | <ul style="list-style-type: none"> <li>Owns and exerts operational control over the Keystone Corridor (except line between 30<sup>th</sup> Street–Upper Level, Suburban Station, and Center City Connection)</li> <li>Operates intercity passenger service</li> </ul> |
| PennDOT   | <ul style="list-style-type: none"> <li>Sponsors and partially finances Keystone intercity passenger service</li> <li>Conducts Keystone Corridor planning activities</li> <li>Provides State support to SEPTA for commuter service</li> </ul>                          |
| SEPTA   | <ul style="list-style-type: none"> <li>Operates commuter service</li> <li>Owns and exerts operational control over line between 30<sup>th</sup> Street–Upper Level, Suburban Station, and Center City Connection</li> </ul>   |
| Norfolk Southern  | <ul style="list-style-type: none"> <li>Successor to Conrail</li> <li>Operates local freight service over parts of the corridor</li> <li>Retains (but does not currently exercise) trackage rights for through freight</li> </ul>                                      |
| St. Lawrence & Hudson Railway <sup>40</sup><br>(Subsidiary of Canadian Pacific Railway) | <ul style="list-style-type: none"> <li>Retains (but does not currently exercise) rights to operate freight service between Mileposts 105.2 and 94.3</li> </ul>  |

Further details on the ownership and operating rights on the Keystone Corridor appear in Appendix A.

<sup>40</sup> Formerly, Delaware & Hudson.

## **Services**

Amtrak and SEPTA currently operate relatively frequent intercity passenger and commuter trains over the Keystone Corridor. Local freight service is offered on certain corridor segments as well.

### ***Intercity Passenger Service***

The Keystone Corridor supports two types of intercity passenger service: corridor services, linking Harrisburg, Philadelphia, New York City, and intermediate points; and long-distance services to and from points west of Harrisburg.

### **Corridor Services**

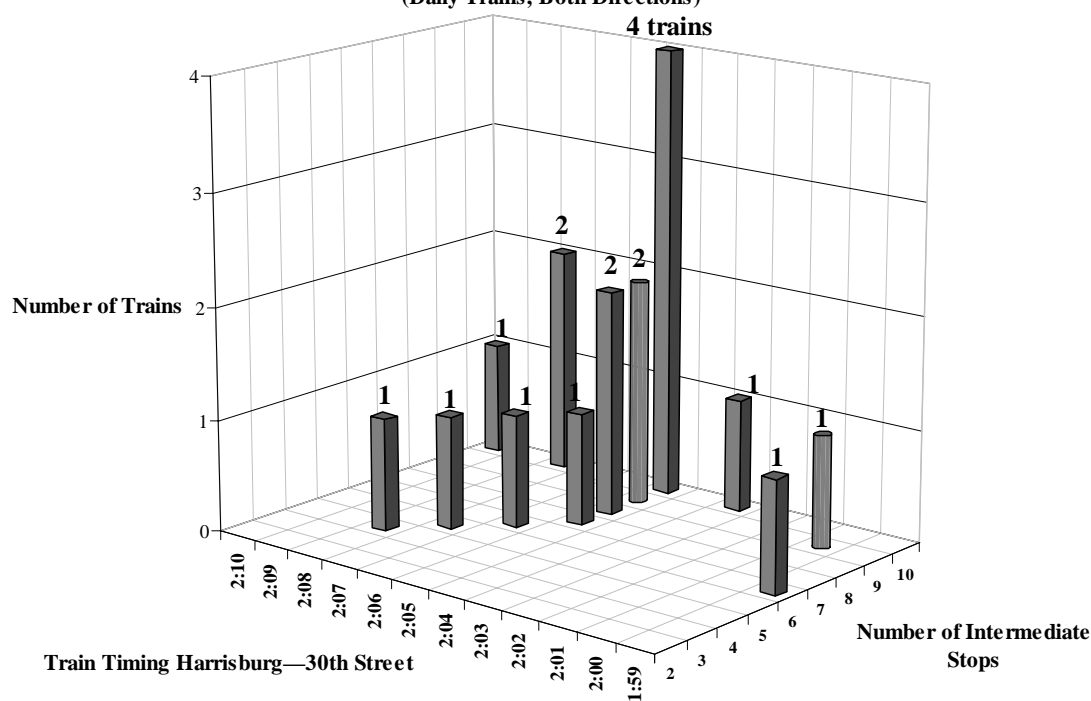
The intercity corridor service, operated by Amtrak, is financed in part through funds made available by PennDOT. Two services are provided: Harrisburg to New York City (six weekday round trips and three weekend round trips) and Harrisburg to Philadelphia (one weekday round trip consisting of a morning and an evening train).

Until 1988 the Philadelphia - Harrisburg service was operated into Suburban Station, in Center City Philadelphia. However, faced with a shortage of electric locomotives, Amtrak chose to substitute Diesel locomotives on Harrisburg–Philadelphia trains and to change the Philadelphia terminus from the centrally-located Suburban Station (accessible only to electrically-powered equipment) to the 30<sup>th</sup> Street Station west of the city center. After this service change, ridership on Harrisburg–Philadelphia Amtrak trains plummeted by 25 percent: from 414,000 passengers in 1987 to 317,000 in 1989.

Subsequently, Amtrak has altered the service. Only one Harrisburg train each way originates or terminates at 30<sup>th</sup> Street. Six of seven trains go to or from New York City, after stopping for 20 minutes to switch between Diesel and electric locomotives at 30th Street Station. For the portion over the NEC main line, these through trains essentially function as Philadelphia–New York regional services within an integral timetable that also includes the “Clocker” and “Northeast Direct” trains.

Figure 2-2 shows current travel times (in hours:minutes), frequencies, and stopping patterns in the Keystone Corridor. Most runs between Harrisburg and 30<sup>th</sup> Street, Philadelphia take 2 hours, 5 minutes and make between eight and ten intermediate stops.

**Figure 2-2: Service Profile for Today's Keystone Corridor<sup>41</sup>**  
(Daily Trains, Both Directions)



The net effects of the changes in Keystone Corridor schedules since 1988 have been as follows:

- Elimination of one-seat (no change) service between Harrisburg, Lancaster, and Philadelphia's Center City; and
- Increased travel times on through services between Harrisburg and New York City—now four hours, as opposed to the 3 ¼ hours in earlier timetables.<sup>42</sup> While significant for all riders making use of both the Keystone and Northeast corridors, the longer trip times are proportionately most perceptible to through travelers covering shorter distances—for example between the Philadelphia Main Line and NEC points.

Chapter 7 of the FRA's commercial feasibility study<sup>43</sup> (CFS) discusses the marketing and competitive characteristics of shorter corridors—i.e., under 130 miles. In such short corridors, subject to local peculiarities and traffic conditions, the CFS suggests that high-speed rail may typically provide **door-to-door** travel times inferior to those of the automobile. Since rail starts from a competitive disadvantage, any worsening of rail door-to-door trip times—such as the cancellation of direct rail service to the heart of downtown,

<sup>41</sup> Adapted from Amtrak's Northeast Timetable, Spring/Summer 1999, pp. 20-21. Only trains providing service among Keystone Corridor points are included.

<sup>42</sup> A single weekend train now makes the trip in 3 hours, 40 minutes. Times in 1990 were as short as three hours, ten minutes westbound and three hours, twenty minutes eastbound. The increase in travel times results from the poorer acceleration of Diesel power and the time consumed in the locomotive change.

<sup>43</sup> *High-Speed Ground Transportation for America*, September 1997, pages 7-4 ff.

or the increase in line-haul timings, in the Keystone Corridor—could divert the affected traffic away from rail to the highway.

**Figure 2-3: Traffic Trends in Keystone and Related Services, 1981-1999**

(Note: Data for 1995 are Unavailable.)

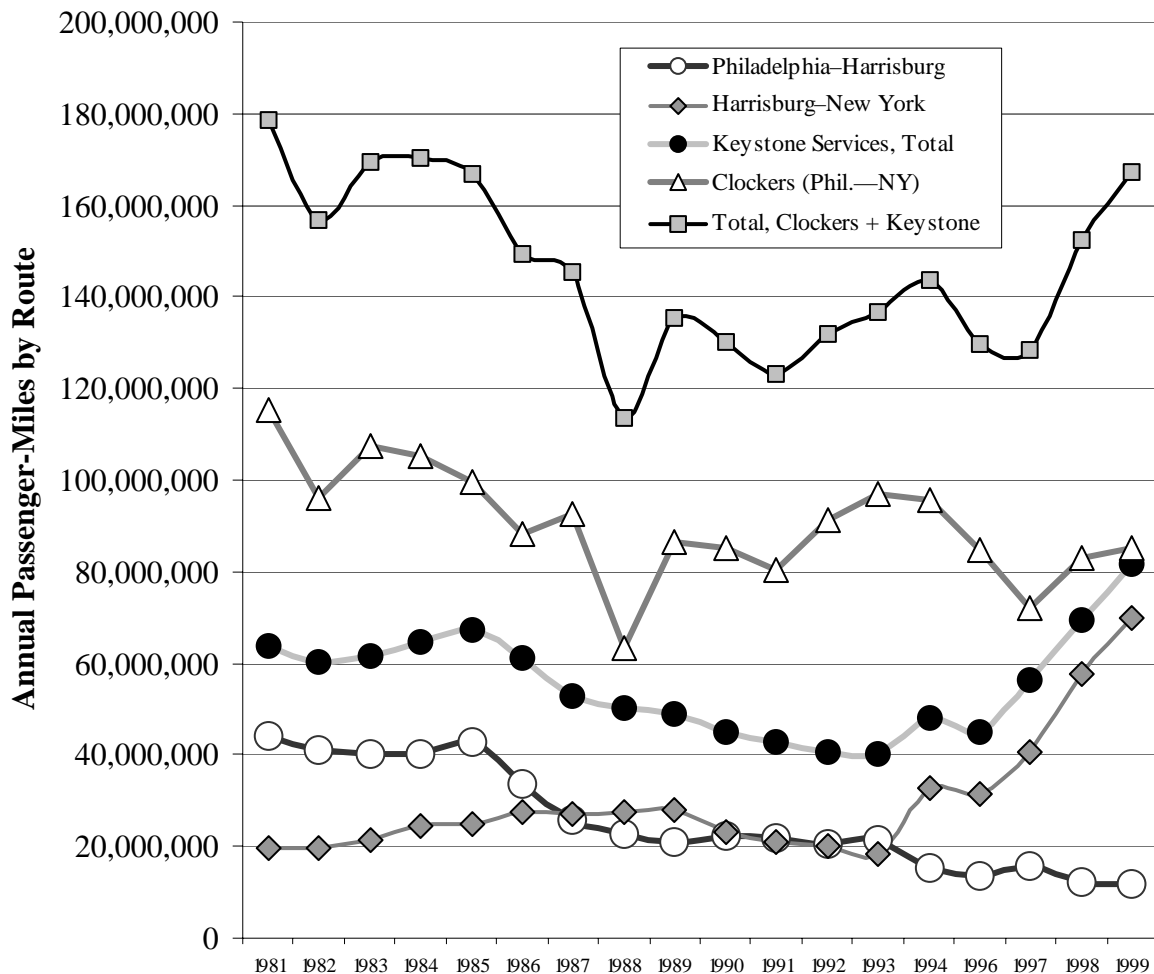


Figure 2-3 points to the following trends:

- Total traffic on the two related services (Keystone Corridor and Clockers) declined by about 10 million passenger-miles from 1981 to 1999.
- Clocker traffic—25 percent lower in 1999 than in 1981—accounted for the bulk of the decline.
- Keystone traffic shrank by one-third between 1981 and 1993, but rebounded strongly since the mid-1990s.

Amtrak's restructuring and partial merger of the Keystone and Clocker services at least partially accounted for these traffic trends. Between 1993 and 1997, Keystone trains

between Harrisburg, 30<sup>th</sup> Street Station, and New York assumed the transportation functions of some Clockers: as indicated in Table 2-4, the Clocker service lost, and the Keystone service gained, about 100,000 annual train-miles in that period. Meanwhile, the Clocker's loss in traffic volume (measured in passenger-miles) was partially counterbalanced by a gain in Keystone traffic.

**Table 2-4: Changes in Clocker and Keystone Routes, Mid-1990s**

|                               | New York-Philadelphia "Clockers" |             | Keystone Corridor Services<br>(Harrisburg — Philadelphia,<br>Harrisburg—New York) |             |
|-------------------------------|----------------------------------|-------------|---|-------------|
|                               | Passenger-Miles                  | Train-Miles | Passenger-Miles   | Train-Miles |
| 1993                          | 96,740,000                       | 273,000     | 40,077,000  | 539,000     |
| 1997                          | 71,968,000                       | 178,000     | 56,499,000  | 646,000     |
| 1997 More (Less)<br>than 1993 | (24,772,000)                     | (95,000)    | 16,422,000  | 107,000     |

Since 1997, Amtrak has succeeded in increasing the traffic volumes on both the Clocker and the Keystone services. Because of the complexity of, and interrelationships between, Amtrak's Northeast and Keystone corridor operations and the shifts in service patterns over the period portrayed in Figure 2-3, more detailed traffic analysis—using proprietary Amtrak city-pair ridership data—would be necessary to establish definitive trends. If planning for this corridor progresses, Amtrak and the concerned public agencies may wish to explore past and prospective travel patterns in greater depth.

### **Long-Distance Services**

Apart from corridor-type services, two additional intercity trains operate daily round trips in the Keystone Corridor: the *Pennsylvanian* between New York and Pittsburgh, and the *Three Rivers* between Chicago and New York. The latter does not provide local service in the New York–Philadelphia–Harrisburg city-pairs.

### ***SEPTA Commuter Service***

SEPTA operates a fleet of electrically powered multiple-unit and push-pull trains with the frequencies shown in Table 2-5.

**Table 2-5: Commuter Service Frequencies, 1997**

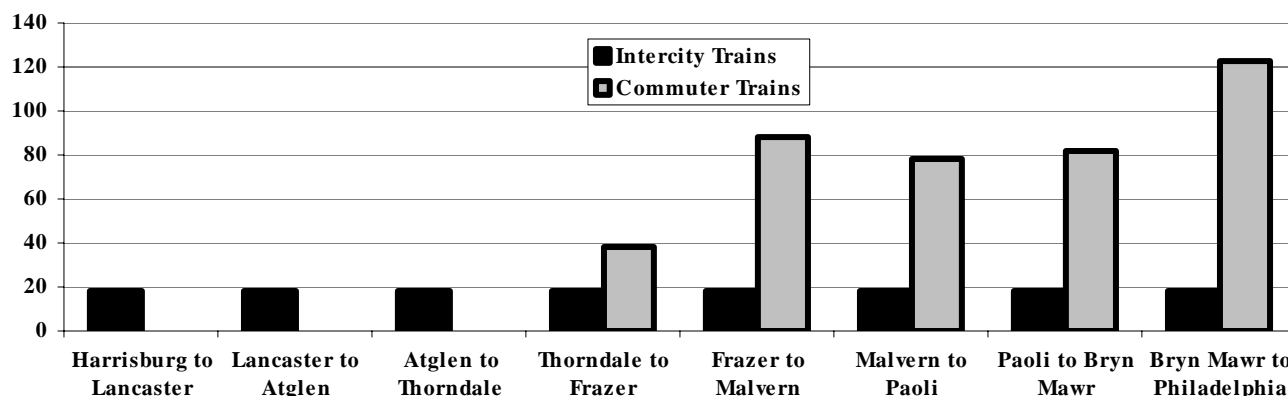
| Between—   | And—                        | Minimum headways:<br>peak hours | Off-peak headways |
|--|-----------------------------|---------------------------------|-------------------|
| Philadelphia<br>(Suburban Station,<br>Center City) | Paoli/Malvern <sup>44</sup> | 10 minutes                      | 30 minutes        |
| Paoli/Malvern                                      | Thorndale                   | 20 minutes                      | 2 hours           |

SEPTA commuter service to Parkesburg was discontinued in 1996.

### ***Passenger Service Summary***

Figure 2-4 shows the number of trains per day (eastbound plus westbound, including nonrevenue runs to move equipment) over each segment of the Keystone Corridor.

**Figure 2-4: Passenger Service Frequencies By Line Segment, 1997**



### ***Freight Service***

No through freight service is operated currently. Local freight service is operated in the evening and early morning hours, from two locations. One enters the Keystone Corridor at Glen, and runs west to a switch at Coatesville, and returns. Another originates at Lancaster and runs east. It provides service at Parkesburg, runs to Thorndale to reverse, then runs west to Middletown or Harrisburg before returning to Lancaster. Other moves are made at Lancaster to service numerous industries in the immediate vicinity.

Thus, while the existing freight service is important to the local economy and must be fully protected, it neither creates capacity constraints nor motivates significant investments in the Keystone Corridor.<sup>45</sup>

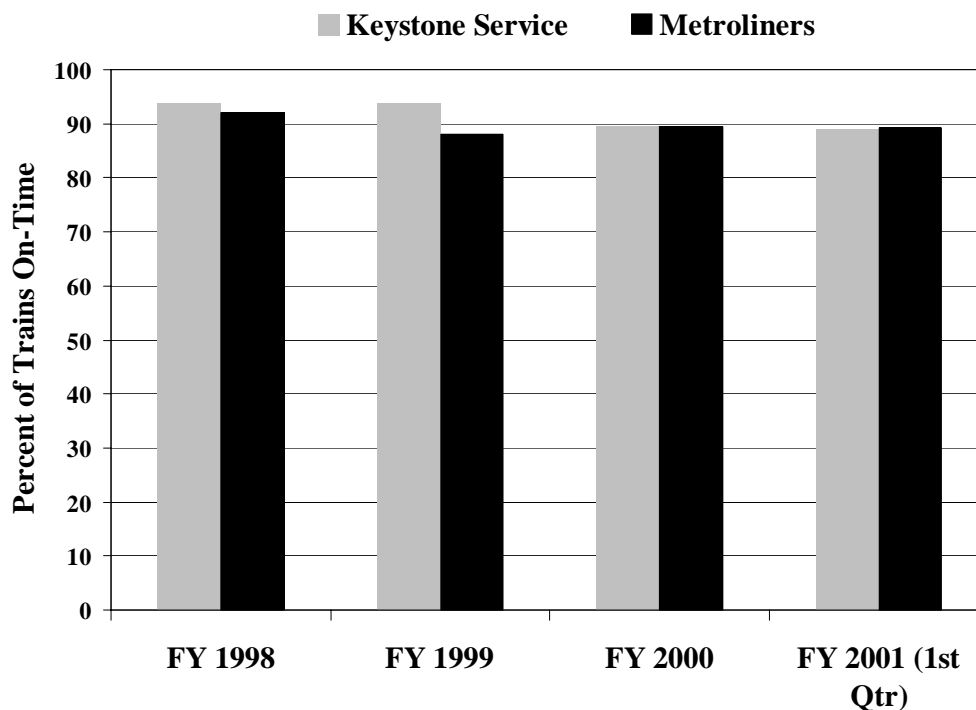
<sup>44</sup> With the opening of the Frazer support facility, Malvern became the westernmost station for “Paoli” trains.

<sup>45</sup> This finding contrasts markedly with the situation on another Northeast Corridor extension—to Richmond, Virginia—which is a freight main line of national significance, and which will require capacity expansion to allow for reliable freight and high-speed passenger service. See National Railroad Passenger Corporation (Amtrak), *Potential Improvements to the Washington—Richmond Railroad Corridor*, May 1999.

## EXISTING SERVICE QUALITY

Amtrak's recent statistics (in Figure 2-5) show that the on-time performance of Keystone Corridor services remains at the 90 percent level—as good as that of the extra-fare Metroliners. Amtrak has compiled this admirable record in spite of a fixed plant much of which dates back to 1938 and before, as described in earlier sections of this chapter. While the Keystone Corridor presents opportunities—detailed later in this monograph—for speed and capacity improvements to accommodate possible future service improvements, the corridor's current utilization does not create serious bottlenecks or necessitate immediate capacity additions, such as new passing tracks, to improve reliability.

**Figure 2-5: Amtrak's On-Time Performance in the Keystone Corridor**



## **Chapter 3**

# **PROJECTED SERVICE GOALS**

To allow sufficient time for planning, funding, design, construction, operation, and manifestation of the effects of such Keystone Corridor improvements as may be implemented, this analysis has adopted 2015 as its horizon year. For each service in that year, this chapter discusses the projections of the respective sponsors and operators.

### **INTERCITY PASSENGER**

This monograph assumes, solely for analytical purposes, that the Commonwealth of Pennsylvania will choose to effect a marked improvement in service, over today's levels, between central Philadelphia and Harrisburg; and that a faster, but less frequent, direct service between Harrisburg and New York will also be implemented. The monograph further assumes that existing long-distance services will continue to operate.

### **Corridor Services**

#### ***Improved Harrisburg–Philadelphia Operations***

For 2015, PennDOT contemplates a 90-minute trip time between Philadelphia's Suburban Station<sup>46</sup> and Harrisburg, with three intermediate stops,<sup>47</sup> at a maximum authorized speed (MAS) of 110 mph. (This compares with current timings, to and from 30<sup>th</sup> Street, of between two and 2¼ hours with up to ten intermediate stops. In the 1940s the PRR offered a timing from Philadelphia's Broad Street Station to Harrisburg of one hour, forty-five minutes with four stops<sup>48</sup>; in the 1970s Amtrak itself linked Suburban Station with Harrisburg in one hour, forty-five minutes with up to nine stops.<sup>49</sup>) As envisioned by PennDOT and assumed in this report, the future service would include one-hour headways during peak periods and two-hour headways off-peak. Such a service would necessarily make use of electrically-powered trains, formed either of new equipment or of rolling stock cascaded from other Amtrak or SEPTA services. The costs of such equipment, which would, in effect, be dedicated to Philadelphia–Harrisburg service, do not enter into the estimates in this report.

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<sup>46</sup> Further marketing, operational, and engineering studies may dictate that trains to or from Suburban Station actually originate or terminate on ex-Reading lines via the Center City Connection. This would afford even better passenger distribution within Philadelphia, thus allowing the Keystone Corridor to compete more vigorously with the private automobile on door-to-door travel times.

<sup>47</sup> As shown in Chapter 5, a schedule with seven intermediate stops could have a running time of just five minutes more, i.e. 95 minutes, between Harrisburg and Suburban Station.

<sup>48</sup> *Official Guide of the Railways*, June 1941, page 288, Table 93, Train 601, "The Governor," dep. Broad Street 6:50 a.m., ar. Harrisburg 8:35 a.m. Eastbound, the equivalent train (No. 600) made the same 4-stop trip in one hour, forty-eight minutes.

<sup>49</sup> Eastern Corridor Timetable, Amtrak, December 15, 1972, page 18.

To tap new markets, proposals have emerged for new stations at Harrisburg International Airport and at Leaman Place/Paradise. To the extent that Harrisburg–Philadelphia trains make use of such new stations within the constraints of five-stop, high-speed service, a skip-stop schedule pattern will be necessary.

### ***Faster Harrisburg–New York Service***

At the time the analysis for this monograph was performed, Amtrak anticipated faster access to New York City for Keystone Corridor riders. This monograph therefore assumes two direct, daily, electrically-powered round trips between Harrisburg and New York—bypassing 30<sup>th</sup> Street Station—with stops at Ardmore and North Philadelphia. Also assumed are two Harrisburg–30<sup>th</sup> Street Station–New York through round trips, with longer schedules than the direct trains. Except for the existing long-distance services, all other existing Harrisburg–30<sup>th</sup> Street Station–New York trains are assumed to be eliminated.

### ***Effects of the Corridor Service Concept***

By 2015, under the service concepts assumed for purposes of this monograph,—

- The study participants expect significant travel demand increases to occur based on markedly faster travel times for all the Keystone Corridor markets.
- Amtrak may need to provide some additional Philadelphia–New York service to compensate for the elimination of most of today’s Harrisburg–30<sup>th</sup> Street–New York “Keystone” through trains, which neither serve central Philadelphia nor provide expeditious service between points west and east of Philadelphia. No costs associated with any such restructured service are included in this report.

## **Long-Distance Services**

The *Pennsylvanian* (New York–Pittsburgh) and the *Three Rivers* (New York–Pittsburgh–Chicago), which make use of the Keystone Corridor, are assumed to continue to operate in the year 2015.

## **COMMUTER SERVICES**

As postulated for this study, the commuter service concept for 2015 includes incremental improvements to existing SEPTA offerings in Philadelphia’s Main Line, and new services to be provided in the Harrisburg region.

### **Philadelphia Main Line Services**

The existing, mature service between Center City and Paoli would remain essentially the same; longer trains would absorb any increases in demand. A new transportation center would be built at Paoli, west of the current station, on the site of the existing Paoli Interlocking, which would be eliminated (see Page 7-11 for particulars). “Paoli” trains have

already been extended to the Frazer shops, with Malvern serving as their westernmost passenger stop.

SEPTA contemplates a significant increase in train frequencies at stations west of Paoli to Thorndale, with limited additional service to Atglen. A new station entered service on November 21, 1999, at Thorndale; SEPTA would also build a station at Atglen and would restore service to Coatesville.

SEPTA is considering a new level of zone express service in conjunction with the increased train frequencies offered to the outlying communities. Referred to as “Flyers,” these trains would make all stops from their western origin to Paoli, then run non-stop on one of the center tracks to 30th Street Station, overtaking the previous local en route. This would complement the present “Limited” service, trains running non-stop from Wayne, and “Express” service, trains running non-stop from Bryn Mawr, to form a three-tiered system of zone express services. As described in Chapters 6 and 7, the contemplated improvements for high-speed rail would directly benefit the express commuter services by creating an expeditious path for all fast passenger services to and from 30<sup>th</sup> Street Station.

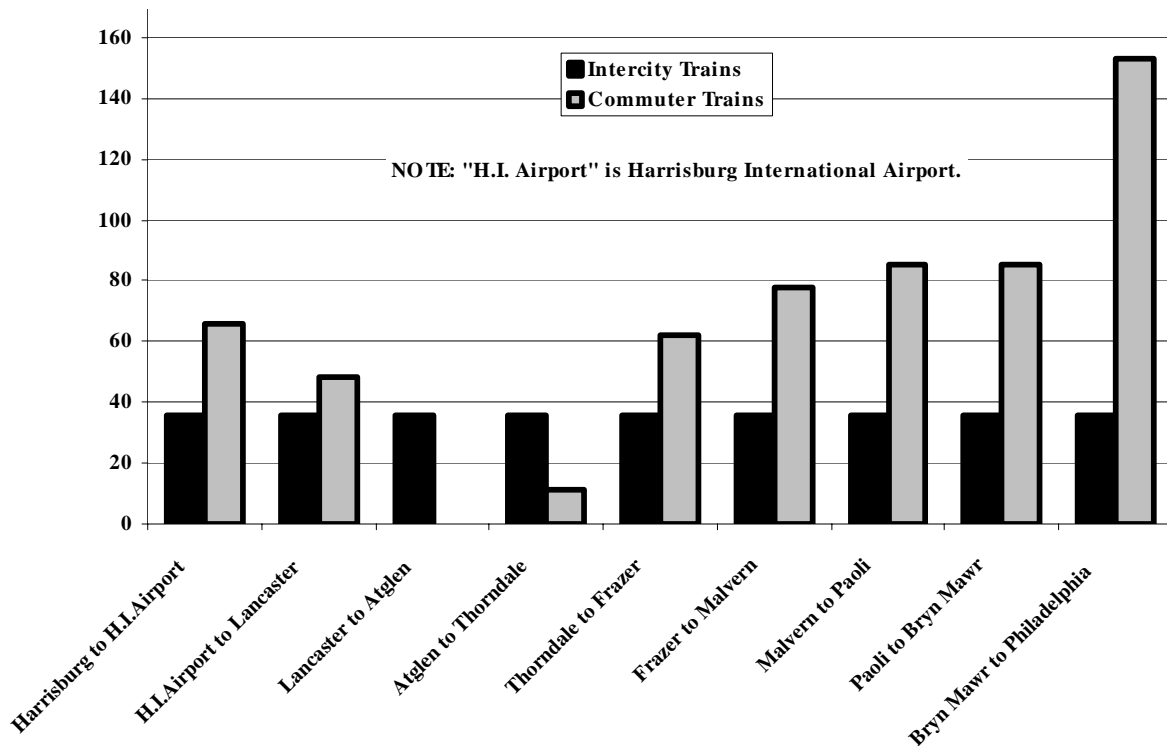
### **Harrisburg Commuter Services**

PennDOT envisions, and this monograph assumes, that the 2015 schedule would include commuter rail service to Harrisburg from Lancaster and Carlisle. (Only the Lancaster service, making use of the Keystone Corridor, figures directly into the present study. A Carlisle service would make use of freight railroads, would have implications for Harrisburg Station operations, and would therefore require intensive analysis.) Such a commuter service would include half-hour headways to Harrisburg International Airport.

### **PASSENGER SERVICE SUMMARY**

Figure 3-1 summarizes the passenger service frequencies assumed in this monograph. All frequencies represent total operations on a typical weekday—westbound trains plus eastbound trains. A “working” timetable for Year 2015 train services appears as Appendix E in Volume II of this document.

**Figure 3-1: Assumed Future Passenger Service Frequencies (Year 2015)<sup>50</sup>**  
**(Total Operations Per Weekday, Westbound Plus Eastbound, By Segment)**



## FREIGHT SERVICES

On June 1, 1999, Norfolk Southern (NS) assumed Conrail's rights to operate freight service over the Keystone Corridor. Although the operating plan in the NS/CSX application to acquire and divide Conrail indicated that NS had no plans to operate through freight service in the Keystone Corridor, subsequent events have led NS and Amtrak to discuss that possibility. For example, freight trains might someday be operated from New Jersey on the currently inactive Trenton Cutoff<sup>51</sup> to Thorndale, then via the Keystone Corridor to Harrisburg, continuing either to the west, in the direction of Pittsburgh, or to the south, via Hagerstown. (Figure 3-2 places these potential freight movements in their regional context.) As NS<sup>52</sup> plans specific operational changes, their impact on existing and planned rail passenger services will have to be evaluated.

Since the precise nature and extent of future freight service on the Keystone Corridor cannot now be estimated, and since the freight operator(s) can be assumed, for purposes of this analysis, to bear the full cost of any investments necessary to support the desired freight operations while protecting the quality of passenger service, no net change in freight operation on the line is anticipated or included in this monograph.

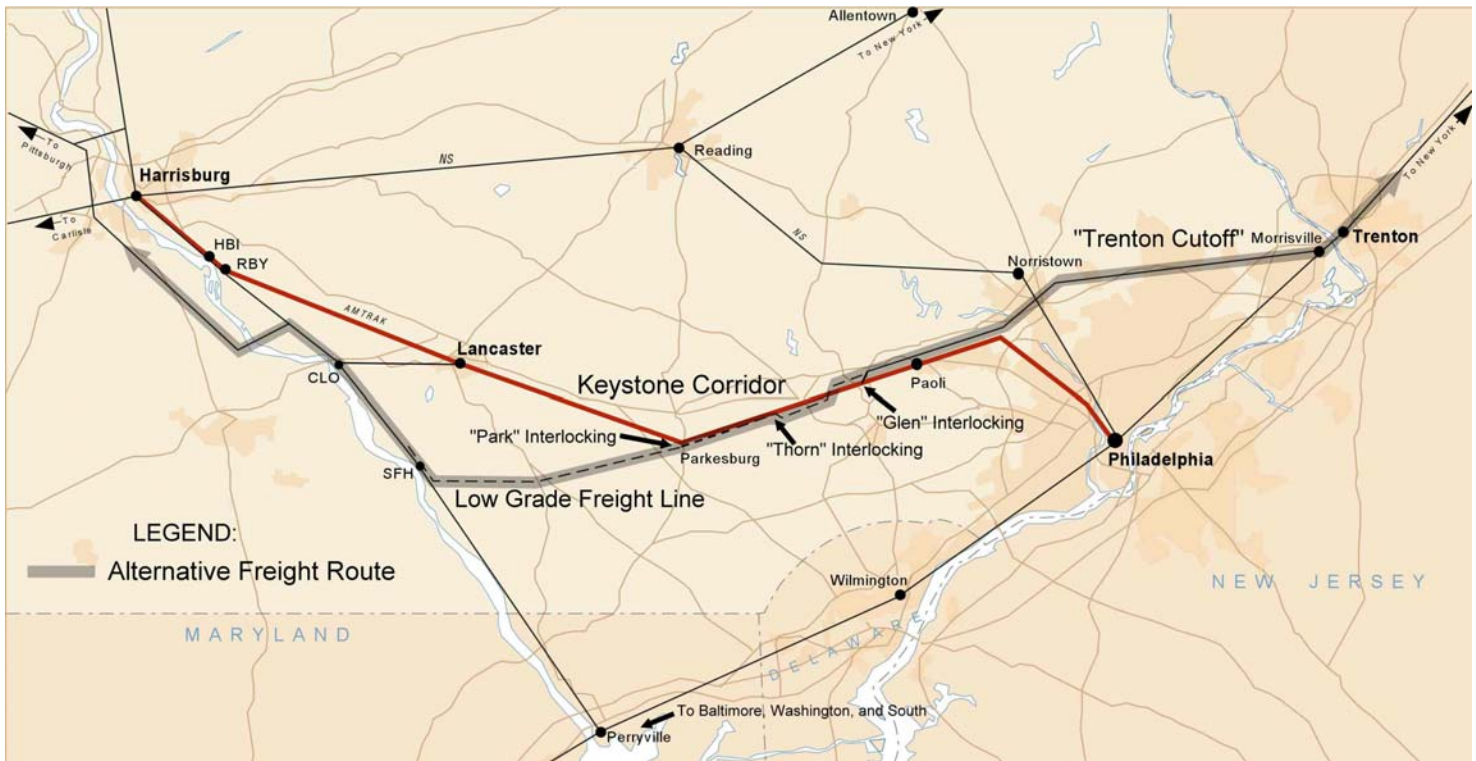
<sup>50</sup> Note: In Figure 3-1, "H.I. Airport" is Harrisburg International Airport.

<sup>51</sup> Throughout this report, the term "Trenton Cutoff" is used to refer to the former PRR freight link between the Keystone Corridor and Northern New Jersey. Conrail referred to this route as the "Morrisville Line."

<sup>52</sup> At this writing, CSX is not asking for operating rights on the line.

**Figure 3-2: The Keystone Corridor in its Regional Context**

NOTE: The presumptive east-west freight route is via Reading and Allentown. A formerly busy alternative route, which declined in importance with the creation of Conrail, consisted of the Low Grade Freight Line, the Keystone Corridor and the "Trenton Cutoff" (see grey line). The freight once used basically separate rights-of-way from the Enola Yard/Harrisburg area through "CLO" and "SFH" to "Park" Interlocking. Similarly, from "Thorn" Interlocking to "Glen," the freight was on a separate right-of-way that skirted the Keystone Corridor to the south, then to the north; the freight line used a large bridge to cross the Keystone Corridor between the Whitford and Exton stations (see the crossing shown below, between Thorn and Glen). East of Glen, the freight line used its own right-of-way to Morrisville and Trenton. Between Park and Thorn, the existing "Track 2" within the Keystone right-of-way carried the former freight traffic; grade separated track connections allowed freight to move on and off the Keystone Corridor without disturbing passenger trains. Other routings were possible; for example, westbound freights could enter (and eastbound freights could leave) the Keystone Corridor right-of-way at Glen, a connection that survives. In the absence of definitive plans to restore the alternative freight route, this study projects that Track 2 will be eliminated between Park and Glen and the interlocking areas at Park, Thorn, and Glen will be rationalized accordingly.



## **Chapter 4**

# **METHODOLOGIES**

Sources for this study included reports prepared by and for PennDOT, track diagrams, maps, equipment specifications, filings before the Surface Transportation Board (STB), and other engineering and ownership documentation. Limited field investigations took place to verify existing conditions. Also, the study team consulted with appropriate Amtrak, SEPTA, PennDOT, Conrail, NS, and FRA officials to assess the status of their respective plans, and to assemble a consensus list of possible projects that would assist all operators to meet their service goals. Extensive inputs, review, and comments were solicited from these agencies and railroads, and numerous meetings occurred to discuss the effort and resolve differences. The work process is described in this chapter.

### **CURRENT STATE OF THE RAIL LINE**

The study team undertook a limited review of the current state of the rail line<sup>53</sup> and its ability to safely and efficiently handle the existing levels of rail services operated by Amtrak, commuter railroads, and freight railroads. The review included, but was not limited to, track conditions and configurations, roadbed and undergrade bridge conditions, signal and traffic control systems, electric traction systems, passenger stations, and maintenance facilities.

Consultations took place among appropriate staff members of Amtrak, SEPTA, Conrail, and Pennsylvania DOT who were involved with rail operations in the Keystone Corridor. The objective was to obtain data on existing and projected 2015 train operations and presently planned improvements to the line.

Amtrak's latest track charts, curve information, track geometry car data, and track program summaries were used in the subsequent analyses. For example, the preliminary analysis of curves between Harrisburg and Philadelphia used the most current available Amtrak track geometry car data, and Amtrak track chart data.

On-site inspections were made, followed by collection and review of all available maps and documents. Current data on existing usage and any plans for upgrading the Keystone Corridor were obtained and reviewed. The results of state-of-the-rail-line investigations were reviewed with Amtrak and state and local transportation agencies so that their concerns and needs were known and reconciled prior to finalizing this report.

After previous documentation was reviewed and augmented, if needed, by the results of field inspections, a summary level description of the condition of, and operations over, the existing Keystone Corridor was developed (Chapter 2). Summaries of assumed 2015

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<sup>53</sup> Essentially as of 1997, the year in which the study began; updated where feasible through the year 2000, when the study ended.

service levels for intercity passenger, commuter, and freight operations also were prepared and are presented in Chapter 3.

A summary of track and station ownership, lease, operating and occupancy rights in the land was prepared (Appendix A). Entities having possible ownership or operating interest in Keystone Corridor right-of-way, stations, and air rights were contacted for this information. The study team reviewed pertinent maps, drawings, agreements (such as those for trackage rights, maintenance, and operations), franchises, Interstate Commerce Commission/STB permits, title documents, and other data relating to ownership and use of the right-of-way (inclusive of all fixed-span bridges), and stations. Both freight and passenger railroad interests between Harrisburg and Philadelphia came under scrutiny.

## **CONTEMPLATED PROJECTS**

The study team compiled a list of planned, proposed, and desired improvement projects to serve as a basis for the preliminary analysis. The list was developed through reviews of prior reports, documents, and improvement programs; consultations with the owners and operators of the railroads, Federal, State, and local government agencies; and field investigations to verify existing conditions. The projected operating schedules of all Keystone Corridor users over the next 20 years were obtained to determine whether the planned improvements would suffice to handle the projected traffic levels.

Specific projects that needed further analysis or conceptual development were identified, and additional supporting information was gathered. Projects that were reviewed included concepts for:

- Upgrading the track structure,
- Installing new signaling and traffic control systems,
- Realigning selected curves to increase operating speeds and reduce trip time,
- Reconfiguring, eliminating, or installing interlockings to improve operating flexibility,
- Replacing the power supply system,
- Removing trackage to reflect decreased freight traffic levels,
- Upgrading undergrade bridges, and
- Initiating station improvements.

As each planned, proposed, or potential project that might affect rail operations was identified, a project data sheet was initiated. The data sheet information included: a description, location in the Keystone Corridor, and the rationale for the improvement.

After the contemplated projects were identified, evaluated and documented, summary geographical presentations illustrating their existing and possible future spatial interrelationships were developed.<sup>54</sup> These are the track charts included as Appendix D.

The process resulted in a list of projects that would, if implemented:

- Meet PennDOT Keystone Corridor trip time goals;
- Enable other services to co-exist at their present levels without degradation; and
- Accommodate projected or future growth or changing conditions, such as new commuter rail operations in the Keystone Corridor.

Scenarios to achieve the best integration of intercity, commuter/local, and freight rail services were prepared, based on the operational constraints identified through analyses of the projected 2015 intercity, commuter, and freight volumes.

Additional projects, beyond those initially introduced, that would enable attainment of the stated goals, were developed and analyzed for possible inclusion in this monograph.

The potential benefits associated with individual projects were identified based on the operational analyses. Where possible, the rail services or localities that would benefit from specific projects were identified. Detailed environmental analysis was not performed; however, experience gained from prior projects was reviewed to ensure that recommended projects could reasonably be assumed to be implemented with a minimum of environmental disruption.

## PROJECT OBJECTIVES

While this monograph emphasizes the location of the contemplated improvements (corridor-wide versus site-specific), the study team also characterized the improvements by their **purposes**, of which the first two categories represent improvements necessary to provide a reliable 90-minute express intercity service between Center City Philadelphia and Harrisburg.

- **Travel time reduction.** Projects in this category generally contribute directly to lower trip times or permit higher operating speeds. Examples include curve and spiral modifications, interlocking reconfigurations, track component upgradings, signal modifications for higher speeds, and use of more powerful equipment with better acceleration.
- **Capacity enhancement.** Projects in this category generally provide additional railroad capacity to preserve a reliable 90-minute trip time, while accommodating higher train frequencies. Typical capacity projects include installation of additional main tracks, higher speed turnouts and crossovers

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<sup>54</sup> Lacking current 40 scale mapping of the Keystone Corridor, planners used photographs, videotapes, and 100 scale valuation maps to evaluate the potential impacts of proposed project alternatives.

that allow for faster diverging moves, and additional signal speed commands. These improvements would help to keep different types of trains out of each others' way.

- Projects undertaken for **recapitalization and other purposes** would fulfill such important purposes as the following:
  - **Public safety prerequisites**—of which grade crossing improvements and right-of-way fencing are prominent;
  - **Cost reduction**—investments that help to save capital and/or maintenance costs. In particular, the Keystone Corridor provides facilities—in some cases, of elaborate construction—for operations that no longer exist or that have decreased in volume since 1938, when the corridor's essential layout was fixed. Removing such redundant facilities could create long-term economies without harming railroad services, as long as the superseded operations are beyond all need or hope of restoration.<sup>55</sup>
  - **System reliability and integrity**—examples include possible replacement of such deteriorated components as the electrical power supply and train control/signaling systems; provision of equipment support facilities; and repair and replacement of bridges.
  - **Marketing**—the provision of a more attractive and convenient experience for passengers, such as through modernized stations and parking. These items can also generate ancillary revenues and may be self-financing in some cases.

Clearly, a given improvement type may address more than one of these purposes. For example, a new electrical power supply will not only make passenger service more reliable (by reducing the likelihood of power outages) but also lower system maintenance costs. Likewise, a new, high-speed interlocking may reduce trip times by establishing a more direct path for high-speed trains, and improve capacity by affording dispatchers a number of new routing opportunities.

## OPERATIONS ANALYSIS

The conflicts and delays that occur when several services co-exist on the same track-age, jeopardizing the reliability of all services, were analyzed using manual techniques, rather than the sophisticated operational simulations used in other similar transportation plans. The sophisticated simulations were judged to be unnecessary for the proposed levels

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<sup>55</sup> For example, there is some question about the future utility of the extensive facilities provided by the PRR to support freight service over the Trenton Cutoff. See the discussion beginning at page 7-14, and Figure 3-2.

of service, in a corridor that does not currently suffer from capacity constraints and provides a 90 percent on-time performance.

Therefore, only Train Performance Calculator (TPC) model simulations of train operations were used to assess the overall quality and effectiveness of the projects proposed to achieve the trip time and reliability goals. The analyses were made to represent the completed projects taken together rather than each project separately.

The TPC runs also were used to establish whether reliable trip times for intercity and commuter trains were possible without degrading other current or future services.

The TPC runs and manual analyses of operations proceeded iteratively with, and formed the basis for, the development of the contemplated program of improvements. Chapter 5 presents the final iteration—the operational benefits projected to accrue from the potential improvements described in Chapters 6 and 7. Further details of the TPC runs appear in Appendix C.

## **IMPROVEMENT COSTS AND SCHEDULE**

Conceptual, order-of-magnitude estimates for each identified project were developed in 1998 dollars.

The study team performed a preliminary phasing analysis to identify project priorities, relative benefits to various users, and the interrelationships of individual projects to others. The phasing of projects reflected project priorities and the proper sequencing of individual construction work items was established. Constraints associated with projects that would depend on track availability for construction were analyzed. In addition, phasing generally took into consideration logistics and procurement of materials and equipment, resource availabilities, environmental approvals, real estate acquisitions, track availability, and funding availability.

Only a minimal assessment of operational impacts during the project implementation phase was undertaken; this topic would, of course, require careful scrutiny in any later stages of planning and design.

Costs for each project included the following engineering considerations, which have been conceptually evaluated for each project and should be included, as necessary, in any later stages of design documentation:

- Lengthen spans in overhead bridges as necessary, or provide new structures adjacent to existing undergrade bridges, to accommodate new or relocated track;
- Revise the overhead catenary system as necessary to accommodate the revised track and interlocking configurations;
- Remove catenary facilities that may not be required for present or proposed train operations;

- Relocate wayside signals, as necessary, to accommodate the new track;
- Revise the signal spacing in advance of the new interlockings as part of upgrading the signal system (described in a separate project);
- Install No. 20 (45 mph) crossovers and turnouts on the main line whenever practicable; and
- Maintain access to existing sidings and local industries.

## **TOPICS FOR POSSIBLE ADDITIONAL STUDY**

This study focused on opportunities for fixed plant improvements that could—if fostered by the Commonwealth of Pennsylvania—lead to improved travel times over the Keystone Corridor, while expanding its potential for reliable commuter service. However, the recent history of this corridor, the evolving service goals of its principal operators and sponsors, the advisability of definitive and concerted service design and marketing strategies through the year 2015, and the current absence of funding to complete the contemplated projects, suggest the utility of additional—and conclusive—joint planning work by PennDOT, Amtrak, and SEPTA, should these organizations choose to pursue corridor development.

For example:

- The present study did not identify the potential changes in Keystone Corridor intercity ridership, revenues, and costs, that could result from implementing the contemplated projects and the assumed 2015 intercity rail service schedules.
- Operational analysis of the link between the upper level of 30<sup>th</sup> Street Station and Center City Philadelphia—SEPTA’s busiest segment—would be prerequisite to the restoration of intercity passenger service there.
- The intentions expressed by PennDOT and Amtrak in 1999 with respect to this corridor included an allocation of resources for electric locomotives and upgraded passenger cars. However, the present study addressed the related topic of equipment storage and maintenance in a very limited way. If all the partners should arrive at a conclusive design for their future Keystone Corridor services—including intercity, SEPTA, and Carlisle–Harrisburg–Lancaster lines—and consequent rolling stock requirements, additional analysis of maintenance and storage facilities supporting the Keystone operations may be necessary.
- While the infrastructure development program contemplated in this monograph provides the most detailed information currently available, an actual implementation would, of course, necessitate more detailed stages of engineering data collection and design. For example, the study team concluded that—if the contemplated improvements are to be effected—the

Keystone Corridor would need to be surveyed to reflect current conditions and enable final design of curve and other improvements to be completed.

- Also if the contemplated improvements are to be effected, any partners in Keystone Corridor development would need further data to assist in the prioritization of certain types of investments—on a benefit/cost basis, such as time saved per dollar spent, where applicable—prior to establishing a staging plan for accomplishing and funding the work.
- Of course, if corridor development is pursued, all applicable environmental requirements would need to be fulfilled.

Despite its obvious limitations, the present monograph contains a listing and analysis of contemplated projects that should prove useful both to State and regional decision-makers as they consider whether to develop this corridor, and to engineers and planners as they pursue such further analyses as may be necessary.

## Chapter 5

# ANALYTICAL RESULTS

The computerized and manual operational analyses compared the design and condition of today's Keystone Corridor with the demands that the assumed future service requirements would place upon it. The study team then identified possible improvements and, in an iterative manner, evaluated their impacts on the corridor's transportation capabilities.

This chapter summarizes the results of these operational analyses. Chapter 6 describes potential improvements to the corridor-wide subsystems (for example, track, electrification, and train control); Chapter 7 focuses on site-specific investments and their rationale. Finally, Chapter 8 summarizes all the contemplated improvements and recapitulates the study's conclusions.

### TRAVEL TIME ANALYSES

As shown in Figure 2-2, the typical trip time for today's service between Harrisburg and 30<sup>th</sup> Street Station, Philadelphia is 2 hours, 5 minutes. PennDOT's goal for 2015 is a 90-minute travel time between Harrisburg and Suburban Station, Philadelphia. A train performance calculator (TPC) simulation was performed to assess whether the contemplated capital improvements would permit attaining the 90-minute trip time. The TPC assessed the performance of a single train over a hypothetically non-congested route on a reliable basis. Alternative track configurations, speed restrictions, locomotive models, and train consists were considered. Salient results of these analyses appear in Table 5-1; Appendix C contains additional details.

**The TPC runs confirmed that operating a high-speed train between Center City Philadelphia and Harrisburg within 90 minutes could be reliably accomplished with currently-available equipment.** This conclusion assumes that—

- All contemplated trip time-related projects—both the systemic upgrades in Chapter 6 and the site-specific improvements in Chapter 7<sup>56</sup>—are implemented;
- A 110 mph top speed is permitted in those few sections where speed is not constrained by curves; and
- Express trains are limited to three intermediate stops, including the upper level of 30<sup>th</sup> Street Station.

The reliability of the service based on the above assumptions rests on the following factors:

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<sup>56</sup> Indeed, the site-specific projects, although often at lower-speed locations, have a marked effect on line-haul trip times. See the following section, "Speed Value of Investments."

**Table 5-1: Results of TPC Runs, Harrisburg to 30<sup>th</sup> Street and Suburban Station**<sup>57,58</sup>

| Equipment Type—All with Top Speeds of 110 mph    | Unbalanced Elevation (see footnote, this page) | Harrisburg to 30th Street Station, Philadelphia |                                  | Harrisburg to Suburban Station, Philadelphia |                                  | Evaluation Based on Running Times to Suburban Station, Philadelphia |                         |  |
|--|--|---|----------------------------------|--|----------------------------------|---|-------------------------|--|
|  |  | Number of Intermediate Stops                    | Simulated Running Time (minutes) | Number of Intermediate Stops                 | Simulated Running Time (minutes) | Trip-Time Goal (minutes)  | Resulting Pad (minutes) | Pad as Percent of Simulated Running Time |
| AEM-7 Electric Locomotive plus 4 Amfleet Coaches | 3"   | 6   | 86.6                             | 7  | 91.6                             | 90  | -1.6                    | -2%                                      |
| Silverliner IV Multiple Unit Electric Train      | 3"   | 2   | 83.8                             | 3  | 88.8                             | 90  | 1.2                     | 1%                                       |
| AEM-7 Electric Locomotive plus 4 Amfleet Coaches | 5"   | 6   | 82.5                             | 7  | 87.5                             | 90  | 2.5                     | 3%                                       |
| AEM-7 Electric Locomotive plus 4 Amfleet Coaches | 5"   | 6   | 82.5                             | 7  | 87.5                             | 95  | 7.5                     | 9%                                       |
| AEM-7 Electric Locomotive plus 4 Amfleet Coaches | 3"   | 2   | 78                               | 3  | 83                               | 90  | 7                       | 8%                                       |
| Generic Electric-Powered Tilt Train              | 9"   | 6   | 76                               | 7  | 81                               | 90  | 9                       | 11%                                      |
| AEM-7 Electric Locomotive plus 4 Amfleet Coaches | 5"   | 2   | 73.7                             | 3  | 78.7                             | 90  | 11.3                    | 14%                                      |
| Generic Electric-Powered Tilt Train              | 9"   | 2   | 67                               | 3  | 72                               | 90  | 18                      | 25%                                      |

- Only TPC runs affording a timing between Harrisburg and Suburban Station, Philadelphia sufficiently below the mandated 90 minutes to allow for an adequate schedule “pad” or recovery time, were considered as meeting the trip-time goal.<sup>59</sup>
- No significant freight service, and very little long-distance passenger train service, was assumed in the corridor. As a result, the line would handle mainly SEPTA commuter runs and short-distance intercity trains with origins either on the Keystone Corridor itself or on the closely-related NEC main line. With only Amtrak and SEPTA involved as service operators and sponsors, with so few opportunities for random major delays from services outside the Keystone Corridor, and with the capacity improvements in place as described in Chapters 6 and 7, the line would be under tight and well-coordinated local control and heavily insulated against random delays. The existing, relatively good on-time performance on the line, albeit with less frequent service than is projected

<sup>57</sup> The intermediate stops to Suburban Station include a stop at the upper level of 30<sup>th</sup> Street Station.

<sup>58</sup> Unbalanced elevation (“unbalance”) is a condition in which a degree of superelevation beyond what is actually present in the track will be required to balance the centrifugal force on a train at a specific speed.

<sup>59</sup> For this purpose, detailed simulations in the NEC main line suggest that a “pad” of 7 percent of the TPC time would be “adequate.” In other words, if the TPC run showed 80 minutes, it would support a scheduled time of 85.6 minutes (80 plus 7 percent of 80, or 5.6) and would meet the goal. If the TPC run showed 86 minutes, it would support a scheduled timing of 92 minutes (86 plus 7 percent of 86, or 6.0) and would fail to meet the goal.

for 2015, still establishes a pattern of SEPTA–Amtrak cooperation that can be expected to characterize the future operation.

Table 5-1 demonstrates how an upgraded Keystone Corridor would support a highly competitive center-to-center transportation product between Harrisburg and Philadelphia in keeping with PennDOT’s goals. Cases below the shaded line **meet** the PennDOT trip-time goals with proper pad.

Thus, an AEM-7 locomotive with 4 Amfleet coaches—standard equipment today on the NEC main line—would meet the 90-minute trip time goal over the upgraded facility with three inches of unbalance and three intermediate stops. Such a schedule would be a significant improvement over Amtrak’s existing timings and would allow Amtrak to outperform competing modes of transportation.<sup>60</sup> Higher-performance assumptions, such as the introduction of tilt, would of course yield even further improved capabilities.

Table 5-1 further indicates that AEM-7 and Amfleet-type equipment, operating at up to five inches of unbalance,<sup>61</sup> could—with up to seven intermediate stops between Harrisburg and Suburban Station, Philadelphia—reliably meet a slightly relaxed, 95-minute schedule goal. Thus, with an improved Keystone Corridor as a base, PennDOT and Amtrak would have a great deal of flexibility in fine-tuning the stopping patterns and running times, while offering a significantly improved service.

## SPEED VALUE OF INVESTMENTS

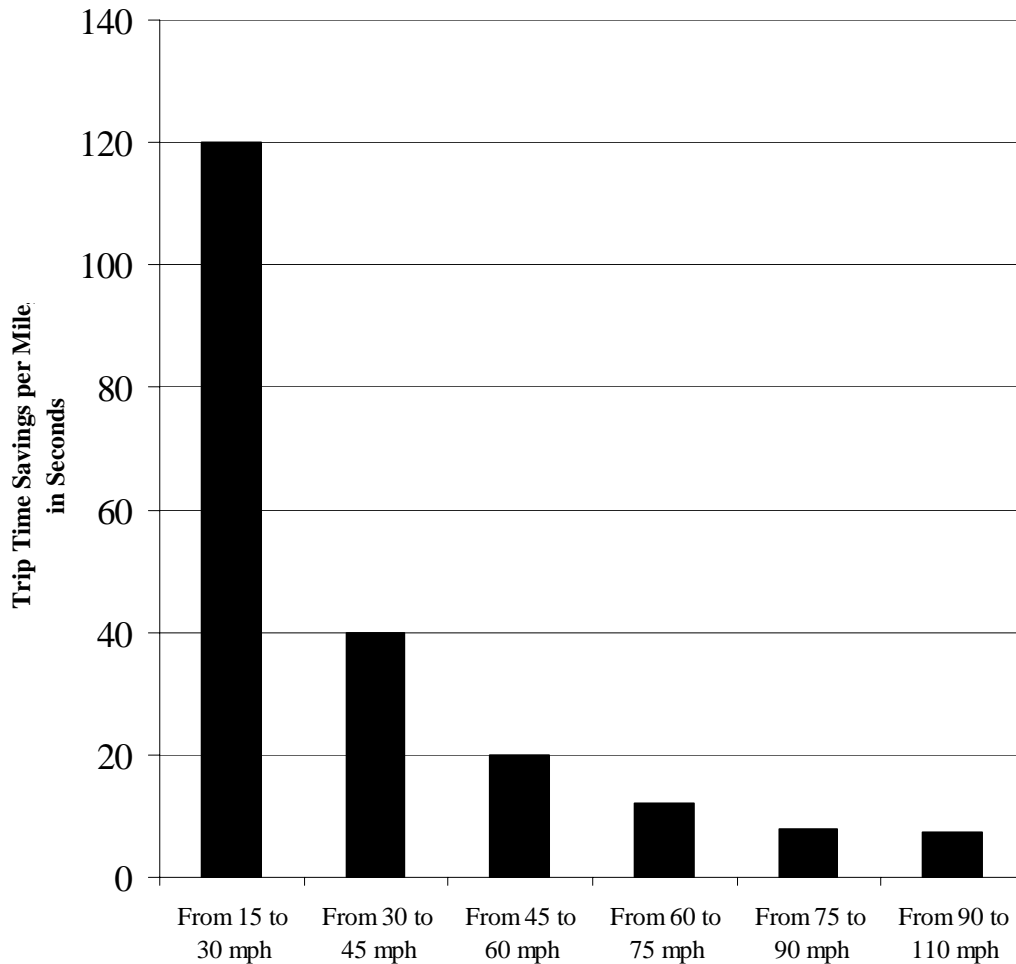
The TPC runs confirm that the desired reduction in Harrisburg–Philadelphia travel times would require careful attention to the detailed, site-specific projects described in Chapter 7. Although concentrated in lower-speed portions of the corridor, these site-specific projects can yield meaningful trip-time reductions because they allow very high **proportional** speed increases. In fact, as the speed limit rises, the proportional effect of, say, a 10 mph improvement decreases. This principle emerges clearly in Figure 5-1: a 15 mph increase in speed from 15 to 30 mph for a distance of one mile would reduce travel time by two minutes, whereas a 15 mph increase from 45 to 60 mph would reduce travel time by only 20 seconds—one-sixth of the value of the increase from 15 to 30 mph.

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<sup>60</sup> Greyhound, for example, in the year 2000 offered express service from Harrisburg to Philadelphia—at a \$12.50 one-way fare (based on round-trip purchase), versus Amtrak’s \$18.00—in as little as 2 hours, 15 minutes. This travel time—assuming that it is reliable—can serve as a surrogate for automobile timings, which would then be superior to Amtrak’s current two hour, five minute schedule **on a door-to-door basis**. (See FRA’s commercial feasibility study, *High-Speed Ground Transportation for America*, pp. 7-4 ff., for a discussion of high-speed rail’s competitive position in shorter corridors in terms of travel times.) However, a 90-minute timing for high-speed rail would, in conjunction with higher frequencies, significantly enhance Amtrak’s time-competitive posture vis-à-vis highway travel, which would continue to be subject to traffic delays at the endpoint urban areas. (Bus information and Amtrak fares in the year 2000 were from the related Internet sites, [www.greyhound.com](http://www.greyhound.com) and [www.amtrak.com](http://www.amtrak.com).)

<sup>61</sup> AEM-7 locomotives and Amfleet cars are FRA-qualified at 5” of unbalance.

**Figure 5-1: Seconds Saved per Mile Improved  
for Various Levels of Track Upgrades**



## CAPACITY ANALYSIS

The manual analysis of train interactions at Year 2015 frequencies culminated in a working schedule (Appendix E) of all weekday commuter and intercity<sup>62</sup> train movements, including service moves to and from storage yards and shops. In constructing this schedule, the study team both confirmed the need for many capacity-related improvements contemplated for the corridor as a whole, and identified a number of improvements at specific sites that would solve operating conflicts that cannot be satisfactorily resolved through timetable changes. For the most part, these potential operating conflicts and

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<sup>62</sup> Local freight movements were omitted as these are so infrequent as to exert little effect on system capacity, in the opinion of the study team. Since no definitive schedules are known at this writing for the possible resumption of through freight service, no provision has been made for the latter. The study assumes that a freight operator wishing to undertake through operations over the Keystone Corridor would bear all costs of supplying the requisite capacity.

capacity shortfalls would reflect the differences between intercity services (operating at average speeds of about 70 mph) and commuter trains (averaging 30 mph) as they overtake or delay each other.

Owing to these operating conflicts, certain segments would not be able physically to accommodate the levels of service projected by all users for 2015 without significant upgrading. Moreover, the segment between Overbrook and 30<sup>th</sup> Street, Philadelphia would require significant betterments to meet trip time and reliability goals for all services.

Chapters 6 and 7 fully address these and other conclusions of the capacity analysis.

## **Chapter 6**

# **CORRIDOR-WIDE INVESTMENTS**

This chapter treats identified corridor-wide possibilities for infrastructure renewal and modernization on a subsystem basis (for example: track geometry, track structure, train control, and electrification). Chapter 7 focuses on the site-specific needs occasioned by the assumed service concept for 2015. Together, these two chapters describe the full range of projects contemplated in the study.

## **TRACK GEOMETRY**

### **Current Status**

Train speed on any railroad is fundamentally limited by the horizontal curvature present in the alignment,<sup>63</sup> regardless of the power rating, method of propulsion, and speed capability of the trains on the line. The Keystone Corridor between Harrisburg and Philadelphia contains more than 100 curves; many of these curves exceed 2 degrees of curvature and are presently restricted to a maximum speed of 80 mph, at 3 inches of unbalanced superelevation.<sup>64</sup>

The maximum speed through a curve that can be negotiated comfortably can be increased by elevating the outside rail, a process known as superelevation. This reduces lateral force by transferring some of it to the vertical plane. In the transition from straight to curve, there must be a gradual increase in superelevation concurrent with a gradual increase in curvature. Review of the track geometry car data has indicated a number of locations on the Keystone Corridor where the transition is not properly made. Superelevation is found to continue from the body of the curve, through the transition, and onto the tangent. (See the related table on page 2-3.) This is a defective condition that detracts from ride quality, accelerates the need for maintenance, and inhibits high-speed operations.<sup>65</sup>

Thus, at present, both the degree of track curvature and substandard conditions of superelevation constrain trip times and reduce riding comfort on the Keystone Corridor.

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<sup>63</sup> Vertical curvature also affects speed, but is not a severe constraint on the Keystone Corridor.

<sup>64</sup> See footnote 58, page 5-2.

<sup>65</sup> For example, substandard superelevation conditions limit the amount of unbalance that the Federal Railroad Administration will permit for specified equipment over specified track. Under such unfavorable circumstances, the full benefits of tilting equipment would not be available.

## Contemplated Program

### *Options for Curve Improvements*

Railway engineers possess several tools for reducing the speed constraints associated with curves—for example:

- Changing horizontal and vertical alignment, either within the existing right-of-way, or by acquiring land outside the existing right-of-way;
- Increasing superelevation to the maximum allowable for a particular track alignment;
- Increasing spiral lengths to accommodate the increase in superelevation;
- Increasing the amount of unbalanced superelevation used to calculate speeds through curves to minimize the need to shift tracks<sup>66</sup>; and
- Modifying spirals (the length of track that provides a smooth transition from level, tangent track to curved, superelevated track) by eliminating superelevation runoff onto the adjacent tangent sections.

### *Selected Analytical Approach: Comprehensive and Optimized*

Based on presumed financial constraints, this study assumed that substantially reducing curvature by means of realignments **outside** the existing right-of-way would not be a practical alternative in the Keystone Corridor. The feasibility of reducing trip times by optimizing superelevation, curve unbalance, and spiral geometrics, and by shifting track alignment horizontally **within** the right-of-way for a number of curves,<sup>67</sup> was analyzed and a preliminary but comprehensive program was elaborated.

Though described here as a single project, the potential improvements would actually consist of a large number of separate “subprojects” at individual curves or groups of curves. While the impacts of improving each curve, considered separately, would be negligible, the time-savings from a comprehensive program addressing many neighboring curves would be substantial, in that sustained and meaningful high speeds would take the place of incessant, energy-inefficient, and ineffectual accelerations and decelerations. The engineering process for evaluating curve treatments—refined during the more than 30-year development of the NEC Project—assures that subprojects with the greatest travel-time payoff per dollar spent would receive the highest priority for consideration.

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<sup>66</sup> Beyond certain limits, this would either reduce passenger comfort or require tilting vehicles, which were not assumed in this analysis.

<sup>67</sup> The contemplated minor curve realignments would not require the realignment of open deck bridges.

## ***Specifications for Curve Projects***

The maximum lateral acceleration allowed in the body of the curve was kept below 0.15 g and maximum rate of change in lateral acceleration was limited to 0.04 g per sec. Spirals for increased speed were calculated in accordance with criteria previously used for the NEC Improvement Project (NECIP) in the late 1970s and early 1980s. Based on ride comfort, maintenance, and spiral length concerns, as well as current FRA regulations, unbalanced superelevation was limited to five inches for commuter and conventional train operations.

Superelevation would be increased (or similarly decreased) at linear rates specified in Amtrak's MW-1000, *Specifications for Inspection, Construction and Maintenance of Track*. All rates are expressed as maximum allowable change in superelevation (fractions of an inch) per 31 feet of distance. This specification presently allows ½ -inch only up to 50 mph; between 50 and 70 mph a rate of ¾-inch is allowed, and above 71 mph a ¼-inch rate is allowed. Additional curve documentation is provided in Appendix B.

Safe braking distances at the increased speeds projected for the Keystone Corridor would be established during the redesign of the signal system, which is treated on page 6-6.

## **TRACK STRUCTURE**

### **Current Status**

Present conditions of track components (as described in Chapter 2) do not allow for the maximum authorized speeds for which the line would otherwise be eligible, and certainly do not permit the 110 mph maximum authorized speeds that would be needed for a contemplated 90-minute service between Harrisburg and central Philadelphia. In addition, certain items of special trackwork (e.g., turnouts and crossovers) unduly constrain train speeds on diverging moves, with adverse impacts on traffic flows.

### **Contemplated Program**

#### ***Ordinary Track Components***

If the Commonwealth of Pennsylvania should wish to effect improved levels of train performance, system capacity, ride comfort, improved safety, and operational flexibility, a long-term, phased track program would be necessary.

Such a program is described in the box on the next page. It is anticipated that these potential track structure investments could be divided into annual track programs covering a period of approximately five years. These programs would coordinate track undercutting, ballast cleaning, installing of wood ties, and laying rail with the other contemplated improvements between Harrisburg and Philadelphia. Ties and rail removed during this program and intended for reuse would be classified and used during future maintenance or construction programs.

#### **CONTEMPLATED TRACK PROGRAM**

- Wood-tie renewals to achieve consistent state of good repair throughout
- Continuous welded rail throughout
- Track undercutting where necessary
- Shoulder ballast cleaning throughout
- Track surfacing
- Replacement or rehabilitation of turnouts, both wayside and interlocking; extensive switch timber replacements

The contemplated track program would provide the track structure needed to support high-speed train operations and would result in increased passenger safety and comfort. In particular, the program—if implemented—would support such increased operating speeds and augmented traffic levels as have been projected for 2015. For example, upon completion of the program, track would be maintained to a standard that would allow operation at higher levels of unbalanced superelevation.

The contemplated investment program assumes that Amtrak would make use of its existing NEC maintenance-of-way bases and maintenance equipment to keep an improved Keystone Corridor at a constant level of high performance.

#### ***Special Trackwork***

If effected, the installation of higher-speed turnouts and crossovers at interlockings and junctions would not only allow for higher speeds at certain locations on normal routings for intercity and commuter service, but also—by reducing the adverse effects of diverting trains from their normal routings because of operating contingencies—would markedly increase line capacity.

### **BRIDGES, CULVERTS, AND OTHER STRUCTURES**

As discussed in Chapter 2, the undergrade bridges and culverts of the Keystone Corridor gave evidence of some deterioration in the course of the limited surveys done for this study. A program to perform detailed inspections of structures would be necessary to identify bridges requiring significant rehabilitation and to prioritize their need to be returned to a state of good repair. Recent bridge inspection reports would be examined to identify bridges to include in the inspection program. Rankings developed by the inspections would be used to establish annual maintenance programs. Retaining walls and other structures would be inspected to establish similar prioritized programs. The program to rehabilitate the bridges would be coordinated with other planned improvements.

For the purposes of this monograph, cost estimates are based on preliminary State of Good Repair estimates prepared for Amtrak in 1995, as well as more recent inspections conducted by Amtrak's Engineering Department. These estimates would be updated and revised as the result of any subsequent inspection and design efforts.

If implemented, rehabilitation of the bridges, culverts, and other structures would eliminate the effects of deferred maintenance and return these assets to a state of good repair.

## **ELECTRIFICATION**

When completed to Harrisburg in 1938, the PRR's NEC electrification at 11 kilovolts (kV), 25 cycles (Hz)<sup>68</sup> was an engineering marvel—a showcase of American technology. Now, over sixty years later, it has become a subject of controversy, in which many engineering experts have recommended it be upgraded from 25 Hz power to commercial power at 60 Hz, while supporters of the existing system have argued for selective replacement in-kind.

The existing Keystone Corridor electrification system was constructed by the PRR in the 1910s, 1920s, and 1930s. In the intervening years it has been operated and maintained by the PRR, the Penn Central Transportation Company, and Amtrak. With the exception of freight-only electrified facilities, which were removed by Conrail, most of the original equipment is still in service, but has deteriorated over the years to the point where its ongoing reliability, as well as its ability to support projected service levels, occasions concern. Major components have been in service beyond their anticipated useful life, and could require major rehabilitation and/or replacement to meet the future service objectives of the Commonwealth of Pennsylvania on an economic and reliable basis.

For example, most of the substations on the existing electrification system entered service in the 1928 - 1935 time frame; their average age is 65 years. Some of the substations that supply SEPTA commuter service in the Keystone Corridor date back to 1915. With minor exceptions, the electrical equipment in the substations is the original equipment energized under the original electrification programs.

Any form of rehabilitation, if implemented, would focus primarily on the substations and power supply facilities. Fortunately, the present overhead catenary system is capable of operation at a higher voltage, although clearance improvements may be required in selected areas. The steel structures supporting the electric traction facility are a major resource for the railroad and can be effectively reused after a comprehensive painting and minor repair program.

Because of unresolved issues concerning the electric traction system in the Keystone Corridor and, more globally, in the intercity passenger territory electrified by the PRR, the cost estimates in the present study include only a limited allowance for the most urgent renewals of worn catenary within the Philadelphia Main Line commuter territory. Beyond that allowance, this study assumes that Amtrak's remaining PRR power supply system will, at an undetermined cost, be so managed as to be in a state of good repair that will protect the reliability of train operations and assure cost-effective maintenance expense levels by 2015.

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<sup>68</sup> Subsequently modified by the PRR to 12.5 kV, 25 Hz.

## **SIGNALING AND TRAIN CONTROL**

### **Current Status**

As indicated in Chapter 2, present signal system components for the most part are beyond their economic life—as much as 60 to 90 years old— and would need replacement or modification if they are intended to accommodate higher speeds, increased train operations, and prospective changes in the electric traction system. Centrifugal relays and cables create particularly expensive maintenance problems.

The existing method for controlling train movements in the Keystone Corridor primarily relies on staffed interlocking towers and voice communications, a time-tested—but costly and superseded—technology. In addition, although locomotives on the Keystone and Northeast corridors have an automatic train control feature that prevents the engineers from violating restrictive signals, the existing system does not automatically enforce speed limits due to curves, bridges, tunnels, and other line characteristics,<sup>69</sup> nor does it enforce a positive stop at locations where conflicting routes can be established. In 1998, the FRA directed Amtrak to install a positive stop/civil speed enforcement system along the NEC main line at locations where speeds may exceed 125 mph<sup>70</sup>; depending on speed and equipment operated, similar provisions may be required from Philadelphia to Harrisburg.

Thus, to the extent that the Commonwealth of Pennsylvania elects to upgrade the capabilities of the Keystone Corridor, its apparatus for controlling train movements could require significant revision due to its physical deterioration and operational inefficiency, changes in traffic patterns, and regulatory trends affecting connecting routes.

### **Contemplated Program**

Under the circumstances posited in the prior paragraph, the Keystone Corridor would require a new signaling and train control system. Although for this function a variety of design concepts would theoretically be available,—including communications-based positive train control, of which various forms are under development in Alaska, the Pacific Northwest, and the Midwest,— this monograph contemplates a new hard-wired, track-circuit-based system for the Keystone Corridor that would extend the analogous system on the NEC main line and that would be compatible with existing standards on SEPTA's lines and rolling stock.

#### ***Compatibility with Electrification***

To allow for compatibility with a possible future conversion of the former PRR intercity passenger electrification to 25kV, 60Hz, the existing track circuitry is contemplated

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<sup>69</sup> Collectively termed “civil speed restrictions.”

<sup>70</sup> “Final Order of Particular Applicability,” July 22, 1998, FRA Docket No. 87-2, Notice No. 7.

to be replaced with new 100Hz phase-selective track circuits. Impedance bonds also would be added or replaced as necessary.

### ***Remote Operation of Interlockings***

Under the assumed configuration, staffed towers would be eliminated and all Keystone Corridor interlockings would be remotely controlled from the CETC Center in 30th Street Station, Philadelphia. Traffic and block information would be transmitted between locations by means of line circuits or track codes, all incorporating state-of-the-art microprocessor-based equipment.

### ***Adjustments for High-Speed, Flexible Operation***

New block layouts, signal aspects, and cab indications would accommodate top speeds up to 110 mph as well as higher intermediate speeds of 60, 80, and 100 mph at such locations as passing tracks, junctions, and high-speed crossovers. To assure maximal operating flexibility, reverse signaling would be installed universally.

### ***Safety Upgrades***

This monograph assumes that the Keystone Corridor would be required to have a positive stop/civil speed enforcement system identical to that of the NEC (see box).

#### **POSITIVE STOP/CIVIL SPEED ENFORCEMENT SYSTEM FOR THE NORTHEAST CORRIDOR**

A speed enforcement system is being installed in the cab of all trains on the NEC to enforce positive stop/civil speed restrictions. The positive stop/civil speed enforcement system enhances safety of trains operating at higher speeds by ensuring that various civil speed restrictions resulting from curves, bridges, etc., and positive stops at locations where conflicting routes can be established, are automatically enforced by fail-safe devices.

This system enforces both permanent and temporary civil speed restrictions and enforces a positive stop at interlocking home signals. Included is a wayside transponder system, which places transponders at the approach to civil speed restriction locations. The transponders contain information about the limits of the speed restriction, the maximum allowable speed through the area, and the distance to the next transponder location. A reader on the locomotive decodes this information and an on-board computer calculates the braking curve necessary to achieve the reduction in speed. If the engineer does not comply, a forced speed reduction is imposed. This technology is being implemented incrementally, both on the wayside and in the vehicles, without detriment to other corridor users whose vehicles as yet are not equipped.

#### ***Modify On-board Cab Signal Equipment***

Certain of the improvements outlined above (new signal aspects, positive stop/civil speed enforcement) would necessitate changes in the cab signal equipment in every locomotive and multiple-unit car operating over the Keystone Corridor. Similar improvements are underway or contemplated on the NEC main line. Since

the affected fleets (Amtrak's and SEPTA's in this case) must be able to operate over both corridors, this monograph assumes that any in-vehicle changes affecting the Keystone Corridor would be governed by the standards—and financed under the rubric—of the

Northeast Corridor main line. Accordingly, these costs do not enter into the estimates prepared for this monograph.

## **SUPPORT FACILITIES**

If the Commonwealth of Pennsylvania should choose to foster an operating plan similar to that posited for this study,—in which 30<sup>th</sup> Street Station would cease to be a terminus for Keystone Corridor trains, and the volume of service would be increased,—a need could arise for upgraded service and inspection facilities at Harrisburg. An allowance for this purpose is included in the cost estimate. However, the specifics would depend on any subsequent equipment and service planning for the Keystone Corridor.

## **STATIONS AND PARKING**

Since the goal of developing the Keystone Corridor would be to provide improved passenger service at the behest of the Commonwealth of Pennsylvania, and since stations represent the beginning and end of each passenger's experience with the railroad, the provision of marketable (and potentially profitable) station facilities, parking, and amenities would merit careful attention and serious consideration as part of any future planning for possible corridor development.<sup>71</sup>

Emphasizing train operations and related facilities, this study has confined itself to identifying only a few of the many issues related to stations and has not included cost estimates. Any future corridor development partners would, however, need to duly treat this topic.

Pertinent issues include the following:

### **Condition of Intermediate Stations**

Although 30<sup>th</sup> Street Station, Philadelphia, and Amtrak's Harrisburg station benefited from refurbishment efforts in the last decades of the 20<sup>th</sup> Century, certain of the intermediate Amtrak-served stations have deteriorated. Should the Commonwealth of Pennsylvania decide to develop this corridor, the intermediate stations would be candidates for possible upgrading with a view toward realizing the traffic and revenue levels projected for such a high-speed service. Marketing studies could assist in properly prioritizing any station investments at these locations, in conjunction with future operating plans.

Table 2-2 provides a listing of the intermediate stations on the Keystone Corridor proper.

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<sup>71</sup> For example, in the late-20<sup>th</sup> century improvement project on the NEC main line, stations played an important role as a focus for local participation and investment, as an image-builder for train service, and as an enhancement to passenger comfort and convenience.

## **Station Locations for Through Service**

In addition, in designing Keystone Corridor services for the 21<sup>st</sup> Century, any corridor development partners would need to consider how to optimize the station locations and stopping patterns in metropolitan Philadelphia, both west and east<sup>72</sup> of Zoo Interlocking, for through New York–Harrisburg trains. West of Zoo, most through trains<sup>73</sup> currently stop at Downingtown, Exton, Paoli, and Ardmore. East of Zoo, five westbound trains currently stop at Cornwells Heights and/or North Philadelphia, while only one eastbound train stops at those locations. Travel demand and market patterns, impacts on train performance, additional facility requirements and costs, space for parking, the likely path of through service,<sup>74</sup> the availability of other potential station sites now served only by SEPTA, and the existence of connecting commuter services are among the factors that could influence the optimization of station choices and train schedules.

## **Americans with Disabilities Act (ADA) Issues**

The ADA requires reasonable accommodation of the needs of the disabled. To implement the transportation provisions of ADA, the U.S. Department of Transportation has issued rules that require all Amtrak stations to meet ADA standards by 2010, with the exception of flag stops. These standards include: accessible routes, signage to include Braille, full accessibility to both east- and westbound platforms, new pavement with tactile edging and striping, modified ticket counters, updated public address and telephone systems, and accessible restrooms. (The next section discusses requirements for high-level platforms.) Commuter rail transportation providers must identify key stations and submit plans to make them fully ADA accessible.

To meet these standards, various improvements would be implemented at SEPTA and Amtrak stations, including but not limited to new platforms (high level where appropriate), new lighting and canopies, and improved public address systems. These actions would make designated SEPTA stations, and all Amtrak stations, fully accessible to disabled passengers.

While assuming that Amtrak and SEPTA will accomplish the ADA modifications, this study does not include the related costs as they would be required even in the absence of any Keystone Corridor high-speed rail development.

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<sup>72</sup> This is the railroad direction. Actually, trains move to and from the northeast.

<sup>73</sup> In the existing service pattern, most trains are “through” trains, although they stop at 30<sup>th</sup> Street for up to 25 minutes for an engine change.

<sup>74</sup> As mentioned in Chapter 3, this report assumes that two of four daily through service round trips between Harrisburg and New York will be provided direct, without a stop at 30<sup>th</sup> Street Station, for minimal travel times.

## Station Platforms and Related Freight Clearance Issues

High-level platforms already exist at 30<sup>th</sup> Street Station, Philadelphia (both levels), Thorndale (eastbound only<sup>75</sup>), Lancaster, and Harrisburg. At Paoli, Thorndale (westbound), and Harrisburg International Airport, this study assumes that high-level platforms would be installed, thereby reducing dwell times—hence train travel times—and enhancing system throughput. (For the center-island platforms to be installed at Paoli and the special arrangement foreseen for Thorndale, see pages 7-11 and 7-16, respectively.) Low-level platforms are assumed to remain in place at all other stations, which generally handle lower volumes of intercity passengers.

A complex of issues pertains to high-level platforms and freight clearances. These issues and the assumptions made about them for this report can be summarized as follows:

**Need for high-level platforms.** The ADA requires passenger-carrying railroads (both intercity and commuter) to provide, by various dates, the ability to transfer people in wheelchairs from platforms to trains by means of either lifts or high-level platforms. While manually operable lifts may be acceptable at many lightly-used stations, major intercity and commuter stations require either full-length or short (“mini”) high-level platforms to effectively serve the disabled ridership while protecting train schedules.

**Normal freight clearance requirements.** Normal freight cars in the United States, regardless of their height, have a maximum width of ten feet, eight inches. Typical high-level platforms (such as those installed on the NEC) allow for a three-inch clearance to the side of a normal freight car to accommodate gauge tolerance, worn wheels and suspension systems, and other variations from the norm. Thus, no conflict exists between high-level platforms and normal freight cars.

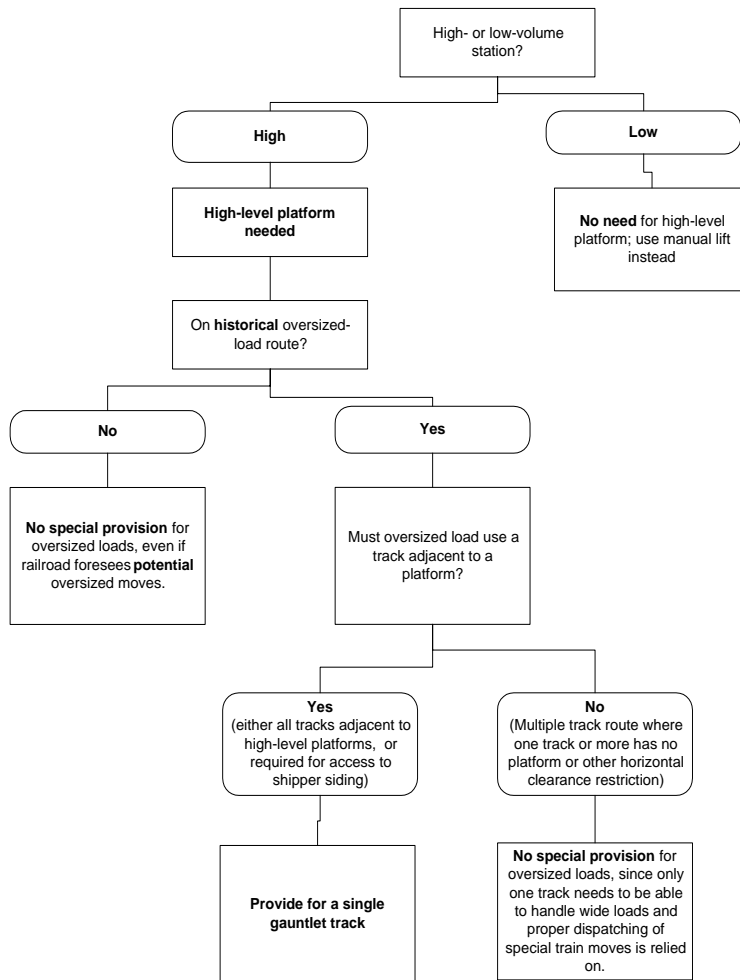
**Oversized freight clearance requirements.** However, freight railroads have historically moved oversized loads in special trains on many routes for the Department of Defense or other special customers. The policy of the FRA, which has governed this study, is depicted in Figure 6-1 and can be described as follows:

Only **if** the railroad has **historically** handled (typically in the last ten years) wide-load clearances **and** the wide loads **must** use a track adjacent to a high-level platform, need a gauntlet track be constructed; and in that case, only **one** gauntlet track is needed.

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<sup>75</sup> The westbound platform at Thorndale has a “mini-high” platform to assist the disabled.

**Figure 6-1: FRA Policy on Oversized Loads and High-Level Platforms**



## Parking

If projected traffic levels are to be realized, an enhanced train service would necessitate expanded parking facilities at the following existing intercity stations along the Keystone Corridor. To project the number of spaces needed at each would require follow-on planning and design work.

| <i>Joint Amtrak/Commuter Facilities:</i>  | <i>Amtrak-Only Facilities:</i>  |
|---|---|
| <ul style="list-style-type: none"> <li>• Harrisburg</li> <li>• Lancaster</li> <li>• Paoli</li> <li>• Ardmore</li> </ul> | <ul style="list-style-type: none"> <li>• Coatesville</li> <li>• Parkesburg</li> <li>• Mount Joy</li> <li>• Elizabethtown</li> <li>• Middletown</li> </ul> |

New stations serving intercity traffic (for instance, Harrisburg International Airport and Leaman Place) would, of course, need parking facilities, which the design phase of these facilities would identify.

This study did not address the provision of adequate parking at commuter-only stations, nor did it address the costs of parking facilities. As demonstrated in the FRA's report, *High-Speed Ground Transportation for America*, parking spaces may provide a source of ancillary revenues to system operators, at locations where remunerative parking fees can be charged in keeping with rail's market position. Whether profitable or not, adequate parking and other station amenities may be regarded as integral to securing intercity rail's position with respect to other modes, if the Commonwealth of Pennsylvania chooses to expand rail's capabilities.

## OPERATIONAL CHANGES

Throughout any Keystone Corridor development,—from detailed planning of infrastructure improvements, to fleet acquisition/augmentation, to construction, to operation of the upgraded corridor,—project partners and other interested parties would need to consult with each other continually regarding the operation of the line. **These consultations would be absolutely essential** because the planning, design, and proper functioning of such an upgraded system would rely on the underlying integrity of the operating plan, the partners' commitment to carrying it out, and the existence of strong mechanisms and policies to resolve disagreements promptly and equitably. Such consultations would be prerequisite, for example, to the following critical actions:

- Revising train routes to eliminate or minimize the number of slow-speed diverging moves that must be made by intercity and commuter trains, and reviewing the effects of these revisions;
- Revising train schedules to enhance reliability while preserving the inherent marketing advantages of the various services;
- Allocating capital costs and operating expenses among participants in a way that affords the proper incentives to all parties to behave in accordance with long-term public policy, minimizes transaction costs, and avoids disputes; and
- Assuring a fair, stable, and prompt method of dispute resolution.

## **Chapter 7**

# **SITE-SPECIFIC INVESTMENTS**

This chapter compares today's Keystone Corridor configuration with the demands that would be placed upon it in the future, if the Commonwealth of Pennsylvania fosters an upgrading program. The contemplated site-specific investments take into consideration the results of the operational analyses detailed in Chapter 5 and the corridor-wide investments described in Chapter 6. While the projects covered in this chapter vary widely in nature and support a full range of objectives, they generally emphasize capacity and redesign of the Keystone Corridor for 21<sup>st</sup> Century transportation purposes, as opposed to those of 1938.<sup>76</sup>

Typical examples of the improvements covered in this chapter include:

- Provision of parallel diverging moves at selected sites;
- Provision of more direct, simpler train routings in place of the complex and time-consuming paths now employed;
- Addition of operating flexibility—for example, new interlockings in territory that currently lacks them; and
- Elimination of redundant facilities that currently add little value to the operation and entail needless expense.

Wherever the following text refers to removal or revision of an interlocking or stretch of track, it includes the corresponding elimination or redesign of electrical and signal system appurtenances and (as appropriate) undercutting of the roadbed for proper drainage and improved track quality. Similarly, wherever crossovers or turnouts receive speed upgrades, corresponding changes—such as signal spacing—would occur in the signal/train control system. As explained in Chapter 6, all interlockings would be remotely controlled from the CETC Center in Philadelphia, under the assumptions of this monograph.

New stations would include necessary parking, provision of ADA-compliant facilities, and passenger amenities appropriate to the station's functions.

The narrative proceeds on a strictly geographic basis, from Philadelphia to Harrisburg.

## **PHILADELPHIA PASSENGER TERMINAL AREA**

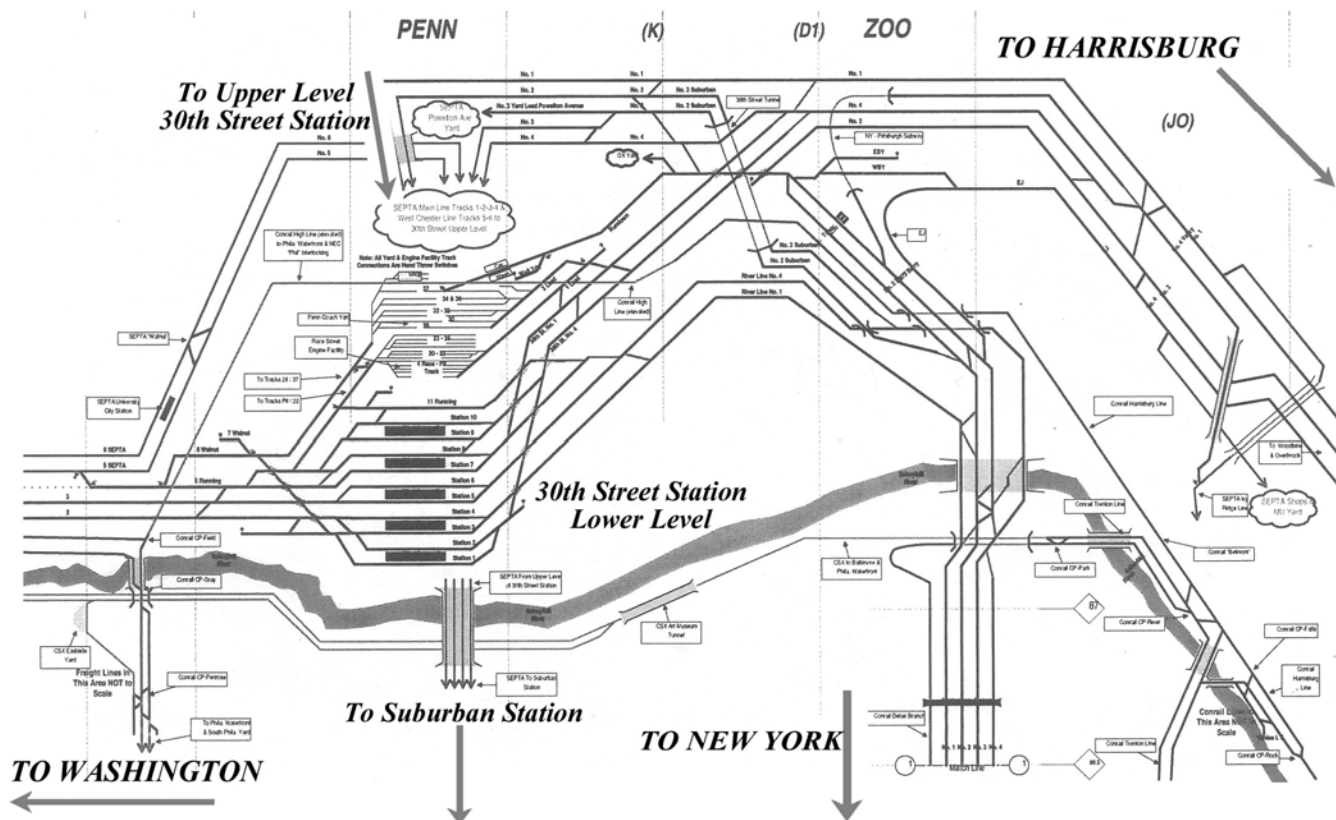
The PRR endowed its home city with a complex and flexible rail passenger infrastructure, allowing a variety of train movements among rail lines to all regions of the United States, facilitating commuter services in Southeastern Pennsylvania, and penetrating Philadelphia to its commercial core. Even after the demise of the PRR, the same style of

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<sup>76</sup> In that year the PRR completed its electrification from Philadelphia to Harrisburg. At that point, the fixed plant had assumed essentially the form it retains today.

Figure 7-1 shows the Philadelphia terminal area as it directly pertains to the Keystone Corridor. Within that area, three types of train movements are of immediate concern:

(Not to scale; North and East are approximately downward.)



- **“Keystone—Northeast”**: Between the Keystone Corridor and the NEC east of Philadelphia (bypassing 30<sup>th</sup> Street Station). This is the historic route for time-sensitive east-west passenger traffic, as it avoids what would be a stub-end terminal move to and from 30<sup>th</sup> Street Station.
- **“Keystone—30<sup>th</sup> Street Upper Level”**: Between the Keystone Corridor and the Upper Level of 30<sup>th</sup> Street Station. This is the movement that would allow the Keystone Corridor once again to provide direct service to and from Center City Philadelphia, which is accessible **only** from the 30<sup>th</sup> Street Station Upper Level.

The two movements listed above do not normally occur within the existing Amtrak service pattern, but would be indispensable under the consensus operating pattern<sup>77</sup> projected for this study. By contrast, existing operations make use of the following movement:

- **“Keystone—30<sup>th</sup> Street Lower Level”:** Between the Keystone Corridor and the Lower Level of 30<sup>th</sup> Street Station. Plans for the corridor must facilitate this move, both to preserve flexibility and to accommodate east-west long-distance trains stopping in 30<sup>th</sup> Street Station. However, under the consensus operating plan, fewer Keystone trains will use the Lower Level of 30<sup>th</sup> Street Station than at present.

These three movements form the basis for the following discussion of the Philadelphia Terminal Area as it relates to the Keystone Corridor.

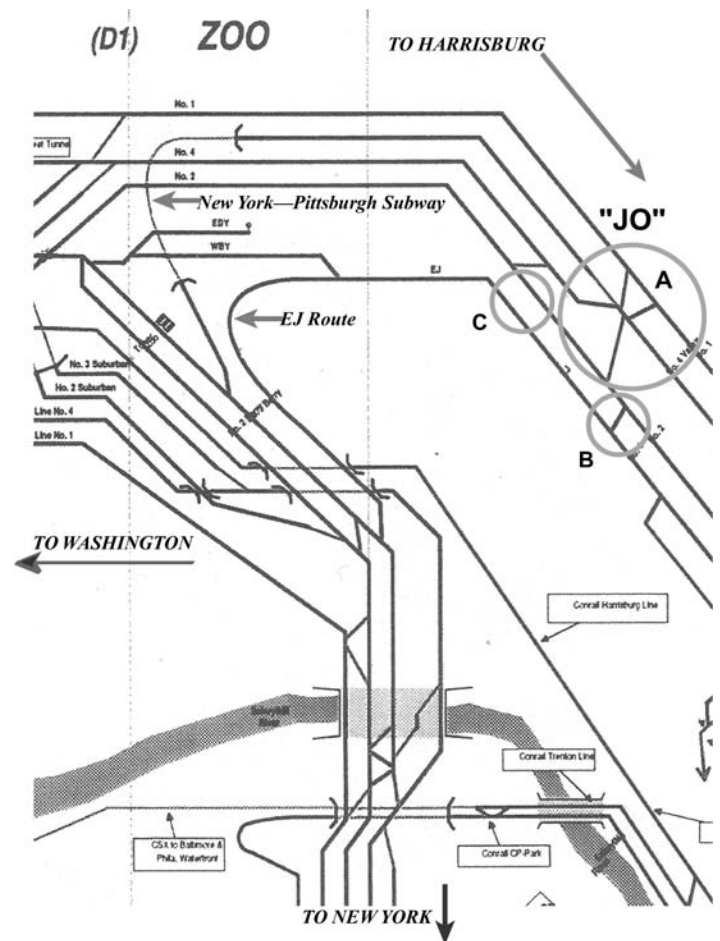
### Facilities for the Keystone—Northeast Movement

At present, two potential routes (neither of them used in revenue passenger service) exist between the Keystone Corridor and the NEC to New York (see Figure 7-2):

- **The New York-Pittsburgh Subway Route**—the traditional passenger bypass of 30<sup>th</sup> Street Station—passes under an old freight yard and links the New York main line with the Keystone Corridor. Until 1994, several Keystone trains daily used the Subway route; they served the Philadelphia area by stopping at Paoli, Ardmore, and North Philadelphia en route to and from New York City.

Within the “JO” portion of Zoo Interlocking, the Subway Route currently has universal track connections to all other Harrisburg Line tracks (see reference point

**Figure 7-2: “Subway” and “EJ” Routes**  
(Schematic not to scale. North is approximately downward.)



<sup>77</sup> I.e., agreed to by PennDOT, Amtrak, and SEPTA as the long-term service objective.

“A” in Figure 7-2). Using the Subway, traffic bound from Harrisburg to New York could—upon completion of other improvements in the vicinity of reference point “A”—move with little or no disturbance to opposing intercity and commuter trains.

Amtrak’s engineering department in the year 2000 conducted an inspection of the Subway and preliminarily found the structure to be suitable for resumption of revenue passenger operations. As the track within the Subway is now restricted to 15 mph top speeds, however, efficient passenger operations would benefit from an upgrading to 30 mph. Further enhancing the utility of the Subway would be the revisions to the track plan at the JO portion of Zoo Interlocking and beyond (see below).

In sum, the Subway Route represents a valuable and immediately available resource to PennDOT and Amtrak should they choose to restore direct service between Harrisburg and New York.<sup>78</sup>

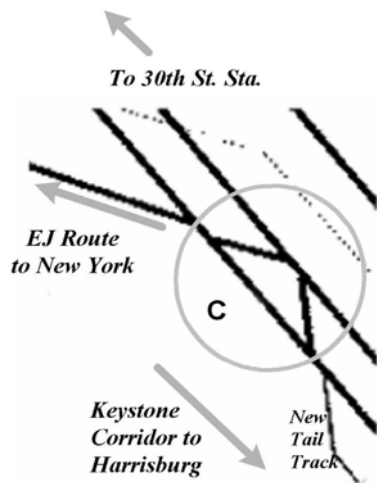
- The **Eastbound Jersey (EJ) route** skirts Zoo Interlocking to the north. Since the EJ route is not grade-separated, any eastbound movement via the EJ route from Harrisburg toward New York would need to cross the westbound tracks at grade, thus conflicting with any Keystone traffic from Philadelphia toward Paoli and Harrisburg. Scheduling the eastbound through trains during the morning rush hour, when most (but not all) opposing moves would be service runs to storage and shop facilities, would help to reduce—but would not eliminate—the effects of such conflicts. In addition, the EJ route currently lacks direct access to and from the Harrisburg Line tracks at “JO”. (The existing crossover, at reference point “B” in Figure 7-2, is oriented contrary to the Harrisburg–EJ route–New York traffic flow.)

Because the EJ route is operationally inferior to the Subway for eastbound traffic (i.e. from Harrisburg to New York), it is not optimal for use as the primary Keystone–Northeast connection. Nevertheless, this monograph on potential improvements includes interlocking revisions at “JO” (Figure 7-3, reference point C) that would enhance operating flexibility for all services and eventually allow the EJ route to carry Keystone–Northeast through traffic should conditions warrant the additional capacity. A new “tail track” accommodating “wye” moves to reverse equipment direction, now performed on the Subway route, would also provide Amtrak with additional operating options.

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<sup>78</sup> Engineering, operational, and public policy reasons abound for keeping the Subway physically and operationally intact, and for considering its restoration as the primary Keystone–Northeast route. From the public policy viewpoint, the Subway route represents existing capacity, which would be next to impossible to replace in the future should public transportation needs ever require it. Thus, failure to keep the Subway intact could foreclose future opportunities and impose future costs. In the very few remaining locations in the United States where rail passenger capacity and flexibility remain extant, as in the Philadelphia Terminal Area, any such permanent and irreversible retrenchment would bear a heavy burden of proof—in this case, a burden that is all the weightier because the facilities are owned by a corporation that receives significant public financial support and, as such, are part of the national transportation infrastructure.

**Figure 7-3: Reconfiguration—  
Junction of EJ Route with Keystone  
Corridor**

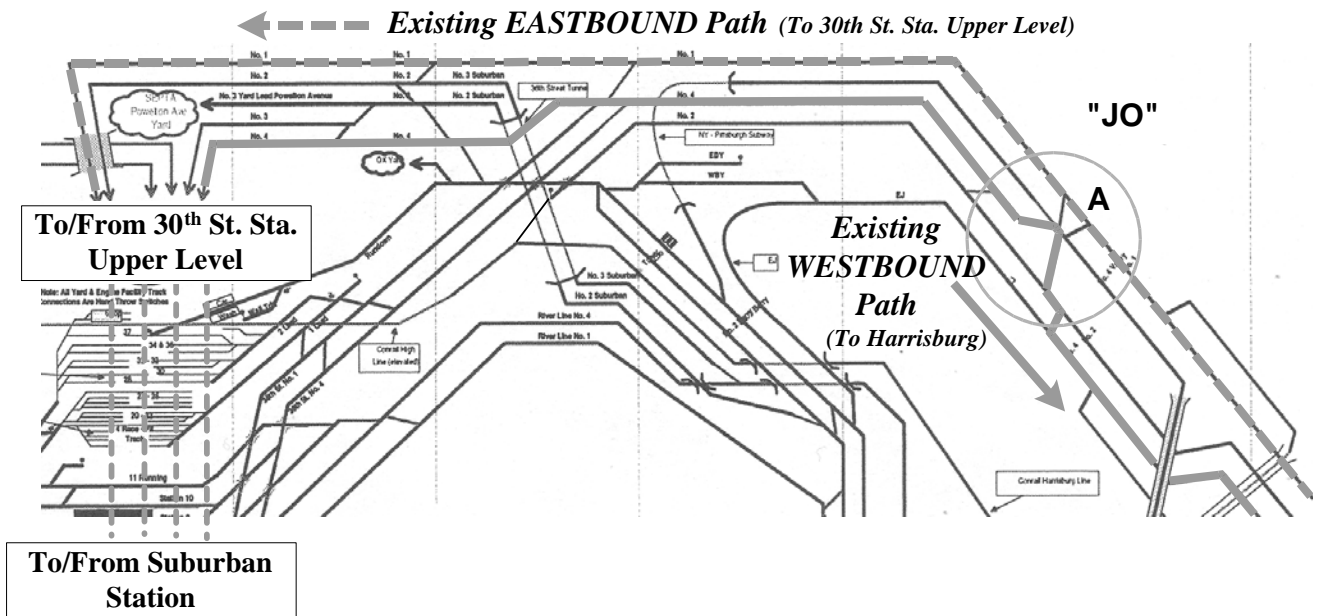


## Facilities for the Keystone—30<sup>th</sup> Street Upper Level Movement

Figure 7-4 shows the existing paths linking the Keystone Corridor with the upper level of 30<sup>th</sup> Street Station, which leads directly to Center City Philadelphia.

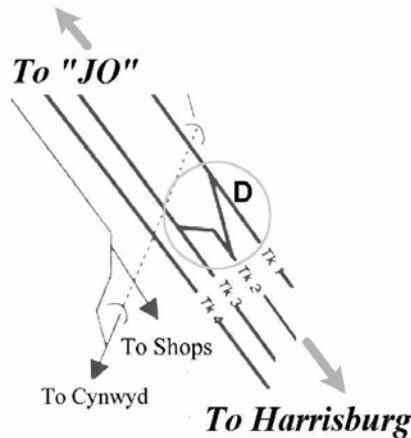
Currently, the **eastbound** move through Zoo Interlocking from the Keystone Corridor to 30<sup>th</sup> Street Upper Level is straightforward for suburban trains, which approach Philadelphia on Track 1. However, under the contemplated operating plan, express commuter and high-speed intercity trains would be moving east on Track 2 and would need to divert to Track 1 more expeditiously than is presently possible at the slow-speed turnouts at the “JO” portion of Zoo Interlocking (reference point “A”) or at the existing Overbrook Interlocking,<sup>79</sup> to the west of the area depicted in Figure 7-4. To correct this impediment, a new high-speed connection would be installed just west of “JO”, at “Valley” Interlocking (see reference point “D” in Figure 7-5). This improvement would raise train speed limits from 30 to 80 mph, a significant time savings for this move.

**Figure 7-4: Existing Paths To and From 30th Street Upper Level**  
(Schematic not to scale. North is approximately downward.)



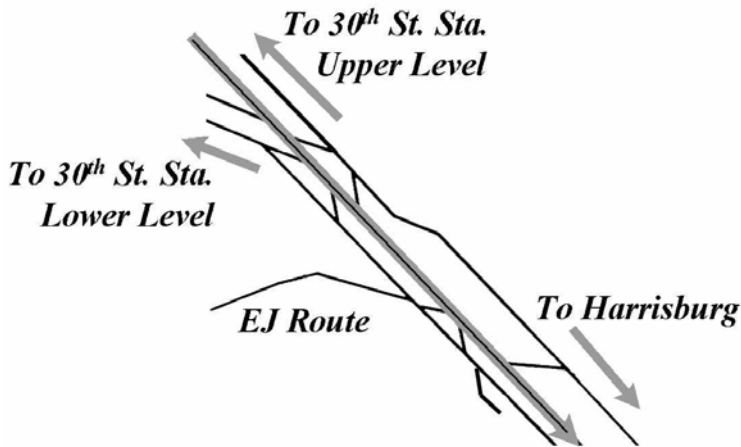
<sup>79</sup> Overbrook Interlocking would, in any event, be eliminated under the contemplated plan (see below).

**Figure 7-5: Change to Eastbound Route at Valley Interlocking**



The existing **westbound** path for trains from 30<sup>th</sup> Street Upper Level to Harrisburg involves two undesirable, low-speed (30 mph) diversions at reference point “A” in **Figure 7-4**. To overcome these delays, Keystone Corridor Track 3 would be reinstalled between Zoo and Overbrook, thus affording a straight move—without diversions—from the upper level of 30<sup>th</sup> Street toward Harrisburg for all express commuter and high-speed intercity trains, and allowing local commuter trains to access their normal path on Track 4 with only one diversion, at a higher speed than at present (45 mph). This improvement, depicted in Figure 7-6, would thus speed up all passenger trains on the Keystone Corridor.

**Figure 7-6: New Path for Faster Passenger Trains, 30<sup>th</sup> Street Upper Level to West**



### **Facilities for the Keystone—30th Street Lower Level Movement**

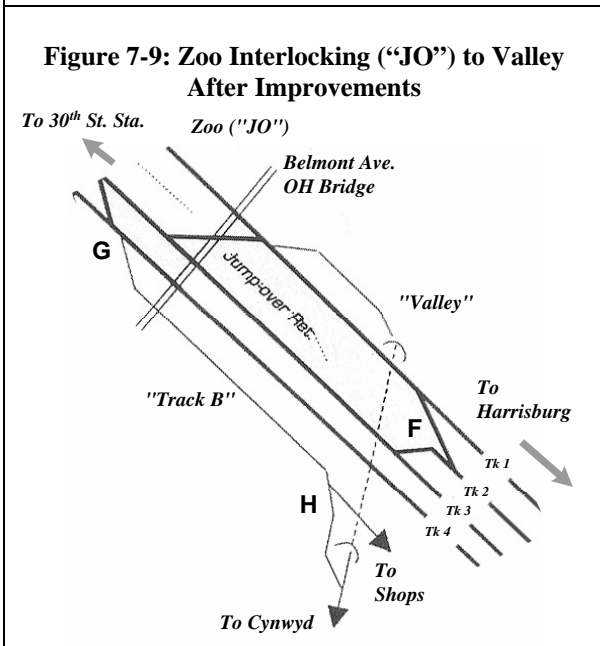
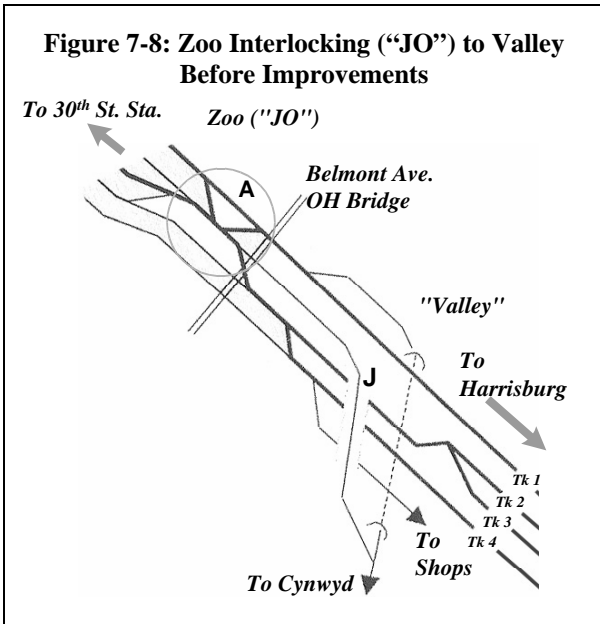
Under the consensus operating plan underlying this monograph, most Keystone Corridor trains would either make use of the Upper Level of 30<sup>th</sup> Street Station (en route to or from Center City Philadelphia), or would bypass 30<sup>th</sup> Street Station entirely via the Keystone–Northeast route. However, Amtrak will still need to provide access between 30<sup>th</sup> Street

Station’s Lower Level and the Keystone Corridor for east-west long-distance trains<sup>80</sup> and for approximately two Harrisburg–30<sup>th</sup> Street Station–New York round trips.

Figure 7-7 shows the existing path—known as the 36<sup>th</sup> Street Connection—between the Lower Level of 30<sup>th</sup> Street Station and the Keystone Corridor. From reference point “E” on the diagram to the west, 30<sup>th</sup> Street Station Lower Level trains use the same route that would be followed by trains to and from the Upper Level (see preceding section), and the major reconfigurations benefiting Upper Level trains would likewise enhance the performance of trains to or from the Lower Level.

<sup>80</sup>As mentioned in the discussion of the Keystone—Northeast Movement, long-distance trains between New York and Pittsburgh (and points beyond) cannot—under present-day market conditions for rail passenger service—bypass 30<sup>th</sup> Street Station, Philadelphia. In addition, for any long-distance trains that may, in future, originate or terminate in Philadelphia, only the Lower Level of 30<sup>th</sup> Street Station affords adequate accommodations for passengers, mail, and express.





moves on Track 2 to speedily merge onto Track 1. This would replace an existing, 30 mph move at reference point "A" in Figure 7-8; the travel time effects would be meaningful, as explained in Figure 5-1.

- Also at reference point "F," to provide additional operating flexibility and afford access for eastbound trains to the EJ Route, a 45 mph turnout would be installed from Track 2 to the restored Track 3.
- A new "Track B," leading to the SEPTA Shops and the Ivy Ridge Line, would be installed from just east of the Belmont Avenue bridge to Valley Interlocking. Access to this track from Keystone Corridor Track 4 would be by a 45 mph turnout (reference point G in Figure 7-9).
- Two 30 mph turnouts and a new connecting track would link the Ivy Ridge Line with the new "Track B" of the Keystone Corridor (see reference point "H" in Figure 7-9). This route would provide the same operational capabilities as—and replace—the existing route to the Ivy Ridge Line using Track 2 on the viaduct (reference point "J" in Figure 7-8). The viaduct would then be removed from service, thereby eliminating the need to rehabilitate the deteriorated structure.

| Maximum Speed for Diverging Moves | Turnout/ Crossover Designation |
|-----------------------------------|--------------------------------|
| 15 mph                            | No. 10                         |
| 30 mph                            | No. 15                         |

| Maximum Speed for Diverging Moves | Turnout/ Crossover Designation |
|-----------------------------------|--------------------------------|
| 45 mph                            | No. 20                         |
| 80 mph                            | No. 32                         |

Normally, speed limits for straight moves through crossovers and turnouts are the same as those for the adjoining track.

## OVERBROOK INTERLOCKING (MP 5.4)

Overbrook Interlocking originally stood at the west end of the 52<sup>nd</sup> Street Freight Yard, which has since been removed and replaced by the SEPTA shops. The contemplated track reconfiguration in the Philadelphia Passenger Terminal Area, described above, would make Overbrook redundant. Furthermore, Overbrook's location in a curve makes it difficult and expensive to maintain.

This project, therefore, would comprise the removal of Overbrook Interlocking (Figure 7-10), including all unnecessary signal apparatus and related catenary appurtenances. Ballast would be undercut over the entire length of the interlocking to improve drainage after installation of the new track structure. Removal of the interlocking from the curve would facilitate track realignments and enable train speeds to be optimized. In addition to these performance advantages, the removal of Overbrook Interlocking would improve maintainability and reduce maintenance costs.

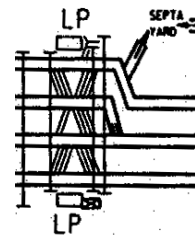
## ARDMORE (MP 8.5)

Although not historically a stop for intercity trains, Ardmore—relatively well-located and accessible, and with a reasonable amount of parking—would serve as a desirable station for travelers to New York City from the eastern Main Line communities.

Ardmore, however, is not presently configured to serve the New York market optimally. Specifically:

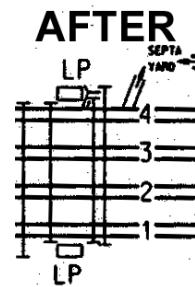
- Platforms now border Tracks 1 and 4 only—the local, rather than the high-speed, tracks. Intercity trains stopping at Ardmore would need to divert to the outside, local commuter tracks, thus losing a few minutes per stop and setting the stage for operating conflicts with SEPTA and other Amtrak trains. Installation of a center-island platform would reduce or eliminate these impacts. This improvement, unfortunately, would be costly in that it would involve a fairly significant realignment of two of the Keystone Corridor tracks in an extremely confined location.
- The platforms are the low-level type, which increases dwell time, because all doors on a train do not open and steps have to be climbed. Car doors must be operated individually to open traps and make steps available to boarding and

**Figure 7-10:  
Overbrook  
Interlocking<sup>82</sup>**



**BEFORE**

← *West*



**AFTER**

<sup>82</sup> In these and similar diagrams, "LP" = "low platform," i.e. for passengers. In most cases in the subsequent diagrams, "LP" refers to a SEPTA commuter station.

alighting passengers. Current practice, with two crew members on board the train, makes two doors the practical limit for safe operation. Furthermore, passengers have to climb the steps with their luggage. This cumbersome process consumes considerably longer station dwell time than stepping directly into the car from a platform at the same level as the floor. High-level platforms would, therefore, enhance passenger convenience and throughput, and reduce dwell times markedly.

Of the four daily Keystone Corridor round trips now projected for 2015 between Harrisburg and New York, only two<sup>83</sup> would offer competitive trip times between Ardmore and New York City, and only one would stop at Ardmore during peak periods. This relatively low service frequency would not, by itself, justify the cost of upgraded Ardmore platforms, which this Keystone Corridor study accordingly omits. The working train schedule for 2015 (Appendix E) assumes that only trains between New York and Harrisburg would make the Ardmore stop and take a slight trip-time penalty for the sake of better serving the Main Line Philadelphia–New Jersey–New York market.<sup>84</sup>

If a high-speed New York–Harrisburg service develops exceptionally strong momentum and ridership, participating entities may wish to reconsider the priority of center-island and high-level platforms at Ardmore, in conjunction with the needs of SEPTA’s commuter service.

## **BRYN MAWR (MP 10.1)**

Present and contemplated 2015 commuter schedules include a number of trains that terminate and originate at Bryn Mawr. As presently configured, trains must turn using the main tracks—tying up main line track capacity—or, if time permits, be moved elsewhere on the railroad for storage. This practice is inefficient and, under the future traffic levels posited for this study, would not be acceptable.

Occasionally, operating conditions also dictate that trains stop on the middle tracks, a procedure that requires passengers to cross the outside tracks to get to the station platforms. This, too, is an undesirable practice, even though the signal system directs trains on the outside tracks to be held outside the station during such mid-track passenger stops.

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<sup>83</sup> I.e., the two Harrisburg–New York round trips making use of the Keystone–Northeast path, bypassing 30<sup>th</sup> Street Station.

<sup>84</sup> Note that this would be a reduction in service to Ardmore, at which all Keystone trains currently stop.

To overcome these challenges, the Bryn Mawr station complex and interlocking would be reconfigured to provide storage tracks west of the present station, off Tracks 1 and 4 (see Figure 7-11). The sidings would access the main tracks through 15 mph turnouts, which would be adequate for this operation.

Reconfiguring Bryn Mawr Interlocking would increase train operating flexibility by enabling trains to originate and terminate at Bryn Mawr without using main line track capacity. In turn, with Tracks 1 and 4 no longer used for train turnaround and storage, there would be less cause for stopping trains on the center tracks.

## PAOLI TO GLEN (MP 19–27)

The objectives of contemplated improvements in this segment are to—

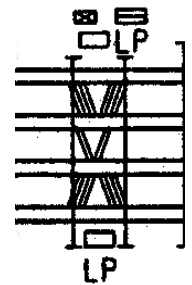
- Provide improved passenger handling facilities at Paoli;
- Provide efficient, easily maintainable interlocking capacity; and
- Improve access to the SEPTA yard at Frazer.

A program such as the following would meet all these objectives.

### Paoli

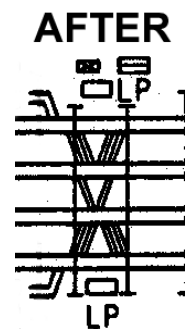
Although Paoli is an important station, served by all passenger trains, its two platforms are low-level and adjacent to the outside tracks only. Just to the west of the existing station, SEPTA plans to construct a new transportation center with two high-level platforms: one platform would be located between the local and express eastbound tracks (Tracks 1 and 2), and the second would serve the express and local westbound tracks (Tracks 3 and 4). In this manner, passengers would enjoy convenient, cross-platform connections between express and local trains—a major mobility enhancement that would better integrate Amtrak intercity rail, long-distance commuter, and local commuter services in Southeastern Pennsylvania. The insertion of two center-island platforms would require the outside tracks (Tracks 1 and 4) to be shifted to the south and north of their present locations, respectively. Room would be provided for the future addition of a gauntlet track on Track 3 to accommodate freight high and wide loads. Site constraints would make it inevitable that the new passenger platforms occupy part of the mild curve just west of the existing station.

**Figure 7-11**  
**Bryn Mawr**



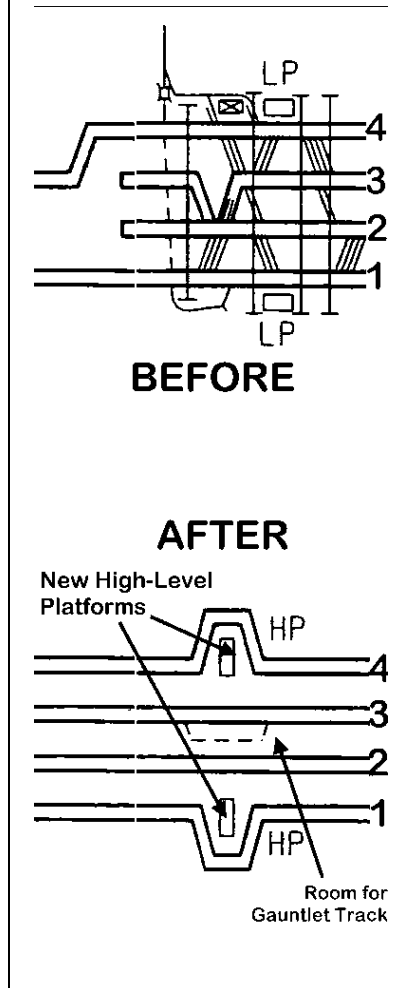
**BEFORE**

← *West*



**AFTER**

**Figure 7-12  
Paoli Interlocking and  
Station**



These platform improvements would reduce dwell times, thus speeding service, and enhance capacity by enabling intercity and commuter trains to make simultaneous stops in the same direction.

The existing Paoli Interlocking—poorly sited on a one-degree, 20-minute curve<sup>85</sup>—no longer serves its intended purpose since SEPTA moved its equipment storage yard from Paoli to Frazer, 4 miles to the west. Accordingly, this study contemplates removal of Paoli Interlocking and provision of equivalent capacity at Frazer.

SEPTA has also made Malvern Station, located west of Paoli and east of Frazer, the westernmost passenger stop for “Paoli” trains. This change is also reflected in the working schedule for 2015 (Appendix E to this report).

On completion of the new Paoli transportation center, the old station complex, including the inter-track fence, would be removed. This report does not include the net cost of disposing of the existing yard tracks, a task that could take place at any time during a Keystone Corridor upgrading project.<sup>86</sup>

### Paoli to Frazer

The improvements between Paoli and Frazer would include the reinstallation of Tracks 2 and 4 (see Figure 7-13).

Track 4 would separate westbound “Paoli” trains approaching Frazer Yard from intercity and outer-zone commuter services; the extension of Track 4 would mandate

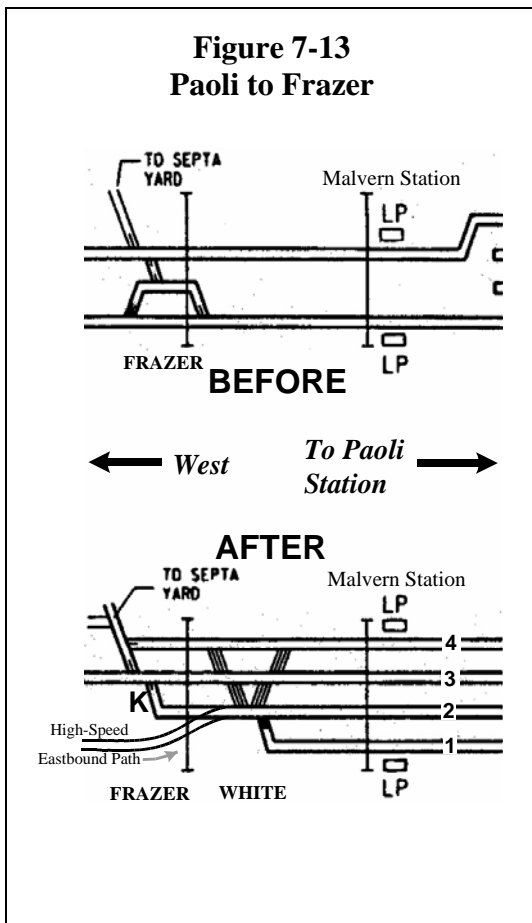
restoration of the westbound Malvern Station platform to its original location adjacent to Track 4, rather than Track 3, as presently configured.

Track 2 would provide holding capacity for eastbound commuter trains departing Frazer Yard (at reference point K). The new, high-speed eastbound path for intercity and outer zone commuter trains, from Track 1 to Track 2, would facilitate access to the new center-island platform at Paoli while bypassing the local moves on Track 1.

<sup>85</sup> Interlockings on curves entail very specialized, nonstandard trackwork that causes undue maintenance expenses.

<sup>86</sup> Cleanup of the Paoli yard could entail sizable costs because the facility antedates by many decades the establishment of environmental safeguards for the disposal of certain toxic materials (PCB’s) associated with electric traction equipment.

**Figure 7-13  
Paoli to Frazer**



The trackage between MP 22 and 24 would undergo complete redesign. To attain universal capability,<sup>87</sup> substitute functionally for the Paoli Interlocking, accommodate the increased track capacity between Paoli and Frazer, and provide better access than at present to and from Frazer Yard, Frazer Interlocking would be reconfigured and a new interlocking, “White,” would be added.

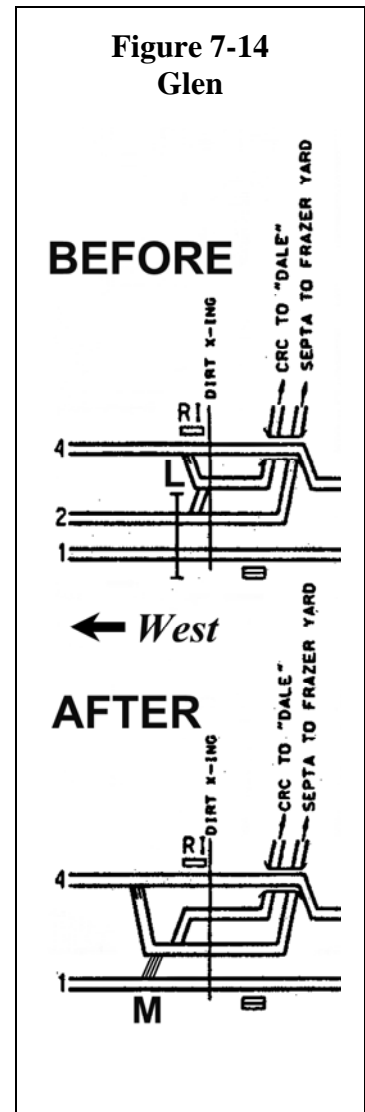
## Glen

Glen Interlocking, west of Frazer, serves two functions:

- It connects Tracks 2 and 4 of the Keystone Corridor with the “Dale Secondary” track, which NS now uses primarily to reach the steel mill at Coatesville, and for a weekly train carrying cars of excessive dimensions.
- It provides access between SEPTA’s Frazer Yard and the west. However, eastbound trains—for example, nonrevenue moves from Downingtown to Frazer Yard—can now access Frazer Yard at Glen only on Keystone Track 2, which is deteriorated. (See Figure 7-14.)

The contemplated program would restructure Glen Interlocking to reflect a major track rationalization between Glen and Park (see below), and to provide relatively high-speed (45 mph) access between Frazer Yard and the west. Specifically, the existing 30 mph turnout (reference point “L”) feeding Dale Secondary and Frazer Yard traffic onto Keystone Track 4 would be replaced with a 45 mph turnout. Meanwhile, the program would install a 45 mph crossover (reference point “M”) from Keystone Track 1 to the Frazer Yard lead track. The existing NS freight connection to the Dale Secondary would function essentially as it does today, but could be upgraded to 45 mph if NS reactivates the Trenton Cutoff.

**Figure 7-14  
Glen**



<sup>87</sup> I.e., the ability to move from any track to any other track in either direction.

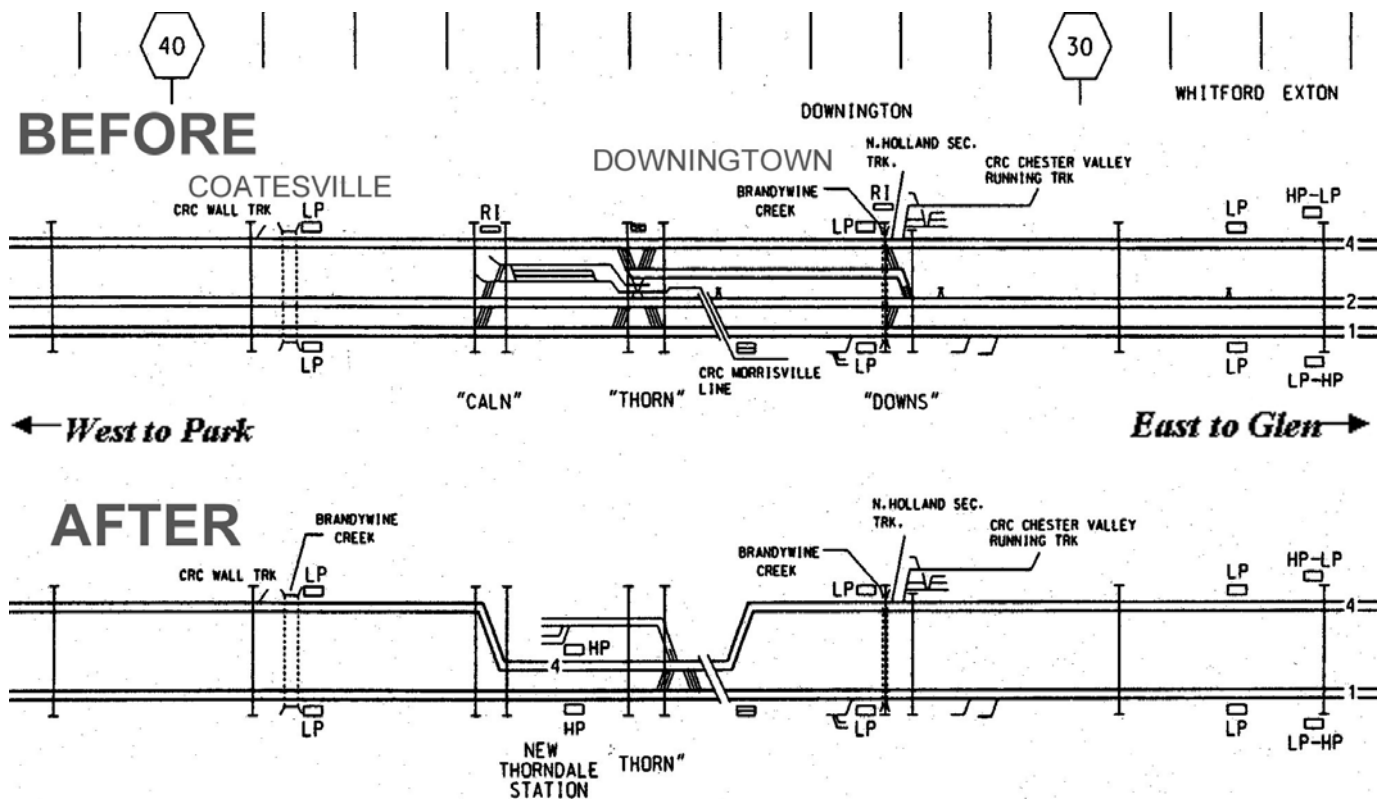
## TRACK RATIONALIZATION: GLEN-PARK (MP 25-44)

The precise capacity requirements between Glen and Park Interlockings will turn on the question whether the NS—the new holder of the freight franchise in this region of Pennsylvania—elects to restore significant through freight service over the Keystone Corridor and the Trenton Cutoff.

### Plan With No Significant Through Freight Service

For analytical and cost-estimating purposes in this and following sections, this report assumes that no such freight restoration will occur. In that case, today's railroad contains

**Figure 7-15**  
**Overview: Proposed Rationalizations Between Glen and Park Interlockings**  
(Assumes No Significant Through Freight Service)



too much multiple track and interlocking capacity for present-day and projected traffic. Much of this excess trackage has so deteriorated as to be, in effect, "abandoned in place." Therefore, the following actions, depicted in Figure 7-15, would preserve ample throughput capability while enhancing operating economy and safety and reducing capital investment needs:

- Remove Track 2, Glen to Park.
- Remove Track 3, Downs to Thorn (MP 35.0).

- Remove interlockings at Downs (MP 32.1) and Park (43.9).

These rationalizations would leave in place the two outside tracks. Except at Thorndale,<sup>88</sup> the remaining right-of-way—once cleared of trackage—would remain available in the event that the transportation needs of future generations necessitate restoration of today’s excess capacity.

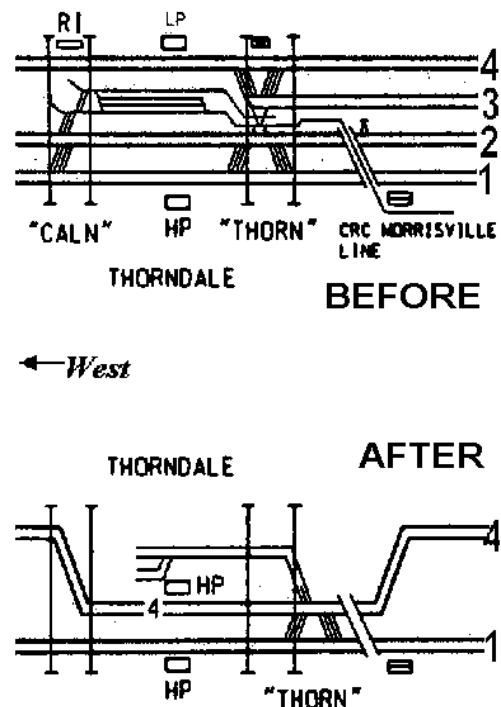
### Alternate Concept—With Through Freight Service

If the NS, working with Amtrak, chooses to reactivate the Keystone Corridor and Trenton Cutoff for through freight service, then the plans for the segment of the Keystone Corridor between Glen and Park will probably require amendment. Specifically, the third track between Glen and Park may need restoration—instead of removal—to accommodate the freight traffic increases, to provide an alternate route for SEPTA trains to and from Frazer yard, and to augment operating flexibility. Specific plans for any such changes, and for allocation of their costs, are beyond the scope of this monograph but could be part of future joint planning efforts by Amtrak, the NS, PennDOT, and SEPTA.

### THORNDALE AND CALN (MP 33–37)

Thorn Interlocking’s present-day complexity (see Figure 7-16) reflects its former role as the junction between the PRR’s trunk and its Trenton Cutoff, a low-grade freight route to and from New Jersey and New York that is currently inactive.<sup>89</sup> Meanwhile, SEPTA intends Thorndale Station—located in a growing region—to play an expanded role in commuter service, as a western terminus for some of the longer-distance Main Line trains.<sup>90</sup> In tandem with the track reconfiguration described further above, and on the same assumptions (i.e., no restoration of through freight traffic on the Trenton Cutoff), these role changes dictate the contemplated improvements in the Thorndale vicinity, which envision—

Figure 7-16  
Detail of Thorn and Caln



<sup>88</sup> As described in the next section, the excess right-of-way at Thorndale now presents significant opportunities for commuter service improvements.

<sup>89</sup> Some of the trackage at Thorn Interlocking once supported “helper” locomotives that the PRR added to some of its freight trains in both directions.

<sup>90</sup> See the description of SEPTA’s planned Main Line services in Chapter 3.

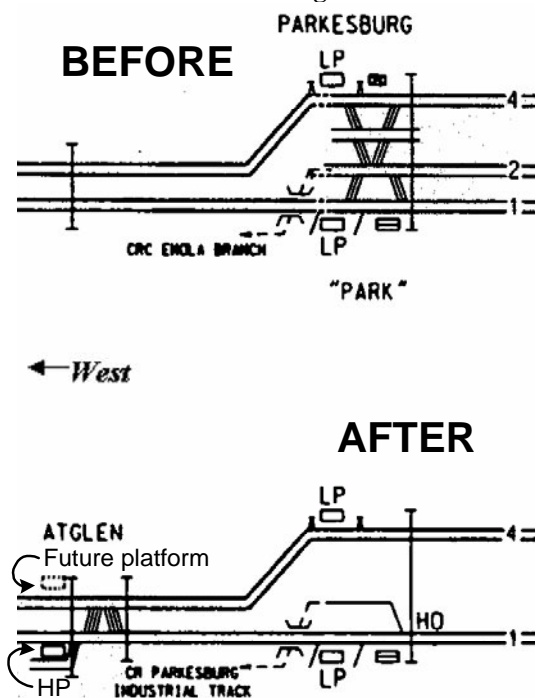
- Shifting Track 4 (the westbound main at this point) to the existing Track 2 position through Thorndale;
- Reducing Thorn Interlocking from its present six-track status to a simpler, universal two-track interlocking with a tail track connection. Relocated to the east of the curve at MP 35, the facility would provide for 45 mph diverging moves.
- Eliminating Caln Interlocking;
- Eliminating all freight-related facilities, including the connection to the disused Trenton Cutoff. As of the year 2000, Amtrak's Real Estate Department planned to sell the property pertaining to former freight operations.<sup>91</sup>
- Building a new "tail track" for turning and storing commuter trains, leading to two stub-end storage tracks, approximately in the position now held by yard tracks;
- Constructing, for the recently-opened Thorndale commuter station, a high-level center platform between Track 4 (westbound) and the tail track, in addition to the existing high-level platform on Track 1 (eastbound). This placement would allow commuter trains originating and terminating in Thorndale to load and unload passengers from the tail track, while passengers could board and alight from longer-distance commuter runs on the main tracks.

Located west of the South Bailey Road undergrade bridge, the new Thorndale station already includes parking, ADA-required accessibility, and passenger facilities appropriate to commuters. However, it currently has one low platform (on the westbound Track 1) and makes use of the pre-existing track layout. The existing station at Downingtown would remain in service for both commuter and intercity passengers.

## PARK (MP 43.9)

Figure 7-17 shows the effects of removing Park Interlocking, where the current four main tracks would be rationalized down to two. Most of the freight service for which Park Interlocking was

Figure 7-17  
Park and Atglen



<sup>91</sup> Neither the revenues from such freight property sales, nor the costs or removal of yard tracks, are included in the estimates prepared for this study.

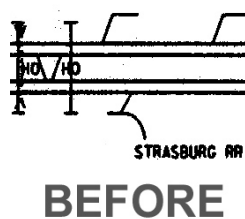
intended no longer exists, and is assumed not to be restored. Access to the Parkesburg Industrial Track would, however, be maintained by means of a hand-operated 10 mph turnout.

## ATGLEN (MP 46–47)

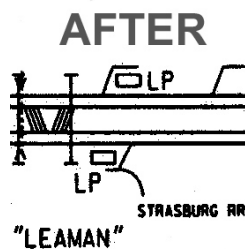
By 2015, SEPTA plans to make a new station at Atglen (about three miles west of Parkesburg) the westernmost terminus of Main Line commuter services. In addition, with the elimination of Park Interlocking, intercity service would require a substitute universal interlocking within the 22 miles separating Thorn and Leaman. To enable the Atglen site to fulfill its commuter role efficiently, and to protect the operating flexibility of intercity services, this monograph contemplates:

- A new station, west of the Pennsylvania Route 41 overhead bridge.
- A new tail track south of Track 1, to be used for originating and terminating SEPTA trains off the main tracks; and
- A new universal interlocking consisting of 45 mph crossovers, and a 30 mph turnout leading to the tail track.

**Figure 7-18<sup>92</sup>**  
**Leaman Place (Paradise)**



← West



These changes appear in Figure 7-17.

Since Atglen Station would serve originating and terminating commuter trains only,<sup>93</sup> it would consist of a single, high-level platform located between Track 1 (the eastbound main) and the tail track. A second high-level platform, north of Track 4 (the westbound main at this point) could be built at a later date, if operational needs warrant.

## LEAMAN PLACE (MP 56–57)

Protecting the double-track high-speed railroad's operating flexibility, a new universal interlocking at Leaman Place<sup>94</sup> would bisect what would otherwise be a 22-mile stretch without interlocking facilities between Atglen and Cork (MP 68.1). The new Leaman Interlocking (Figure 7-18) would allow for 45 mph diverging moves.

Also at Leaman Place, regional officials and PennDOT planners envision constructing a new Leaman Place/Paradise station to serve the railroad museum, the Strasburg Railroad, and

<sup>92</sup> In the "before" view in this schematic, "HO" = "hand-operated turnouts."

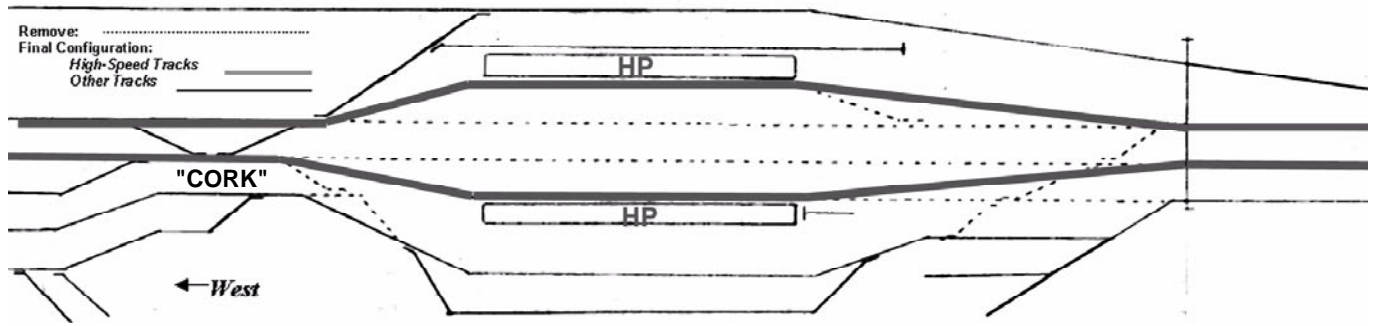
<sup>93</sup> Amtrak trains are assumed to stop at Parkesburg.

<sup>94</sup> Hand-thrown crossovers currently exist at that location; these are of very little use because a crossover movement typically requires about 20 minutes to secure permission, open the switches, move the train, restore the switches to their normal position, and report to the dispatcher that the process is fully complete. This project would, of course, entail removal of the hand-thrown crossovers.

other nearby tourist attractions. The station would fill a gap of about 27 miles where no station exists, between Lancaster and Parkesburg.

## LANCASTER (MP 67–69)

Figure 7-19: Lancaster



At Lancaster, the existing track arrangement requires all passenger trains to divert from the main tracks, through 30 mph crossovers, to access separate side tracks serving the Lancaster Station platforms (see dotted lines in Figure 7-19).<sup>95</sup> For each train, the early braking required by this move consumes an extra 1.7 minutes per stop. The track design would benefit from a thoroughgoing simplification with the following features:

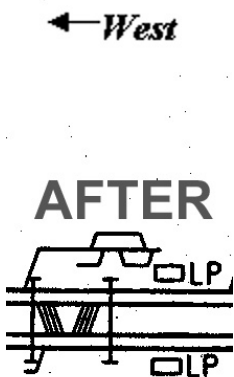
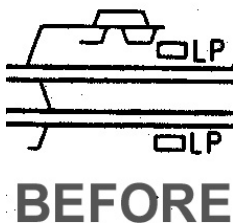
- Realign the main tracks to serve the platforms directly, thus eliminating the slow crossover moves.
- Remove needless crossovers and other surplus trackage.
- Upgrade the portion of the existing universal Cork Interlocking, just west of the station, from 30 to 45 mph.
- Retain separation of freight and passenger trains in the station area through the use of separate freight tracks to reach various industries and branches.
- Add a stub-ended track on the north side of the westbound platform to enable commuter trains from Harrisburg and Carlisle (described in Chapter 3) to be turned and stored without encumbering the main tracks.

Taken together, the contemplated changes in the Lancaster area would speed up service, add to operating flexibility, and reduce operating and maintenance costs.

## OPERATIONAL FLEXIBILITY, LANCASTER–HARRISBURG

<sup>95</sup> The layout in Lancaster is a throwback to the early part of the 20<sup>th</sup> century, when numerous long-distance express trains did not stop there. The economic and operating condition of rail passenger service today does not permit a Metropolitan Statistical Area of 471,000 persons (2000 census) to be bypassed—hence the contemplated redesign. Through freight service, once frequent through Lancaster, no longer exists,—at least as this monograph goes to press,—while local freight movements continue.

**Figure 7-20  
Mount Joy**

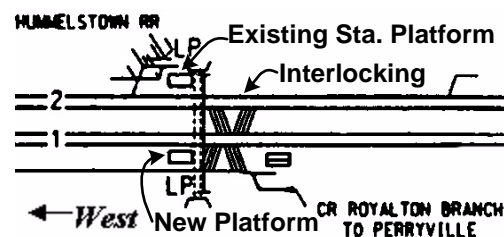


Presently, only Roy Interlocking (at MP 94.3) provides the flexibility of powered crossovers in the 37-mile stretch between Lancaster and Harrisburg. With the increased level of train operations contemplated for 2015, this spacing of interlockings would not suffice to maintain system reliability. If one track is taken out of service due to train operating problems or track maintenance, it would be impossible to maintain train schedules. The recommended solution would be to—

- Install a new universal interlocking with 45 mph crossovers at Mount Joy (on straight track at MP 80), about 11 miles west of Lancaster, as shown in Figure 7-20.
- Upgrade Roy Interlocking (Figure 7-21) from its present 30 mph crossovers, to 45 mph crossovers. Because this is a junction with an NS freight line (the Roylton Branch from Harrisburg to Perryville, Maryland), all four crossovers would be improved.

In addition, the station at Middletown—adjoining Roy Interlocking to the west—currently has only one passenger platform, on the westbound track. If trains continue to stop at Middletown after the Airport station opens (just one mile west of Middletown), operational flexibility would benefit from the construction of a platform on the eastbound track as well, as shown in Figure 7-21.

**Figure 7-21  
Roy Interlocking and Middletown Station, After Improvements<sup>96</sup>**



## AIRPORT STATION (MP 96–97)

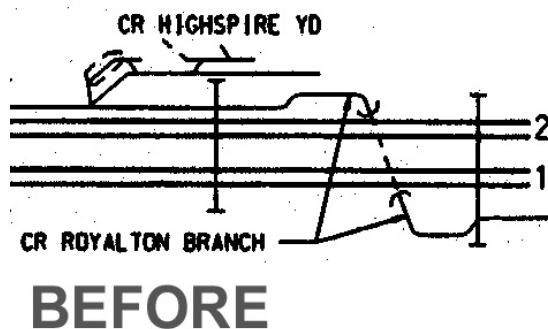
PennDOT planners and regional officials envision constructing a new station between mileposts 96 and 97, near the Harrisburg International Airport, with an overhead pedestrian and vehicular bridge for transfers to and from the airport. Planners expect the new airport station to improve airport access and help to alleviate the rate of growth in congestion on the parallel highway. The station would provide both an intermediate stop for Carlisle–Harrisburg–Lancaster commuter trains, and a terminus for Harrisburg–Airport shuttle trains assuring half-hourly frequencies to the airport.

As contemplated in this monograph, the new station would consist of:

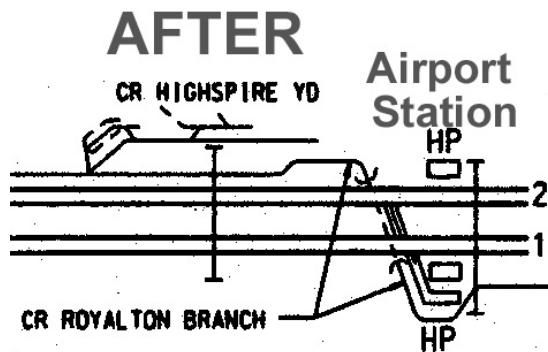
- A high-level platform north of Track 2, ordinarily serving commuter trains en route to or from Lancaster;

- South of Track 1, a tail track ordinarily accommodating shuttle trains turning at the airport;

**Figure 7-22**  
**Harrisburg International Airport Station**



← *West*



- A turnout and crossover linking the tail track with both Track 1 and Track 2; and
- A high-level platform serving both Track 1 (ordinarily for through commuter services) and the tail track (for airport shuttles).

Since a high-level platform and tail track would be located next to the former Conrail tracks south of the Keystone Corridor, the freight tracks may require slight relocation.

The Airport Station improvements appear in Figure 7-22.

### **HARRISBURG (MP 104–105)**

Currently, Harrisburg Station is not designed to accommodate any future high-speed service, in that all arriving trains must make diverging

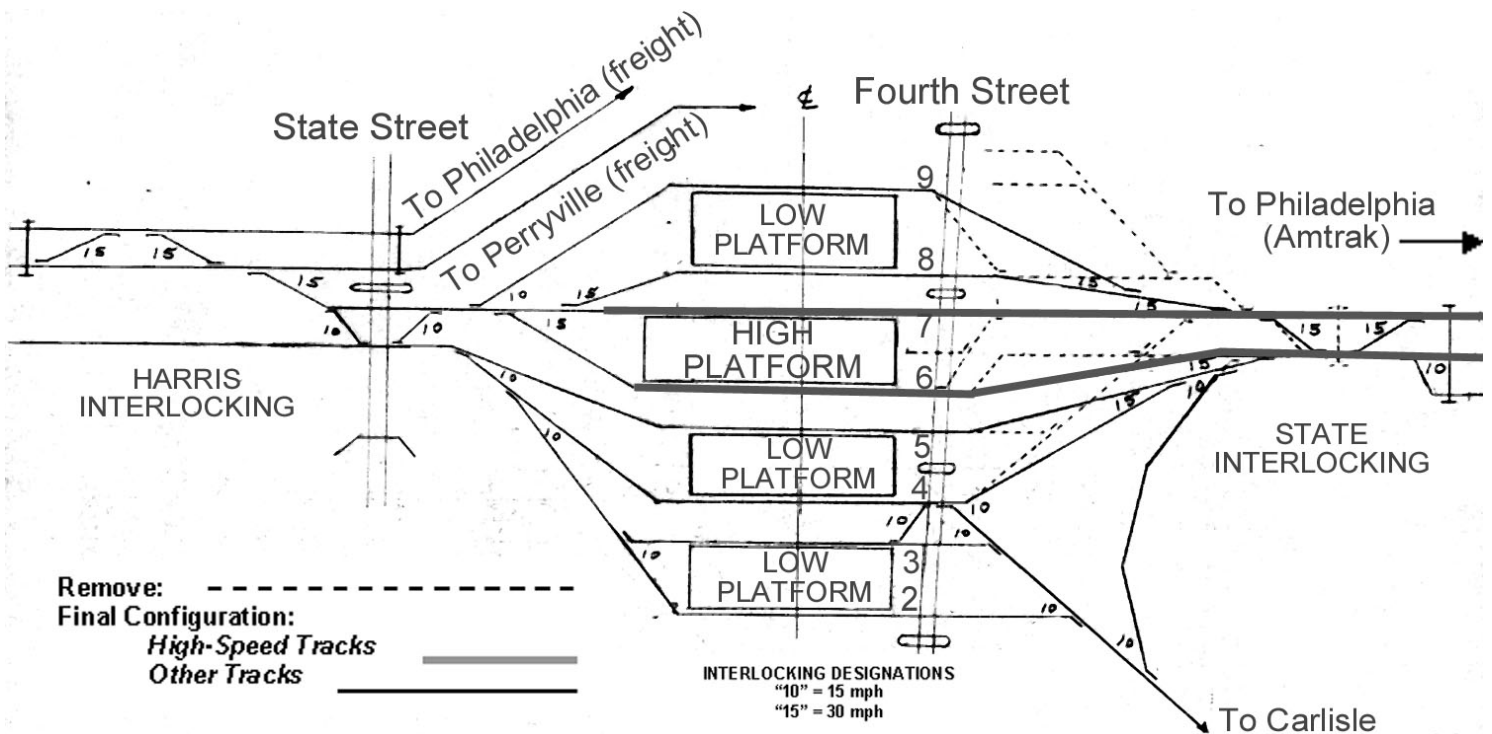
moves through 15 mph crossovers to access the platforms. To safely slow trains prior to making these diverging moves, the signal system restricts train speeds for several miles to the east; therefore, trains take about two minutes more to access the station than a straight path would require. Departing trains likewise face undue delays because of the lack of a high-speed path. In addition, the existing station would not readily accommodate a projected Carlisle commuter service.

As depicted in Figure 7-23, the contemplated restructuring of the track design at Harrisburg Station would—

- Remove redundant trackage, turnouts, and slip switches;
- Provide either a straight move, or a higher-speed diverging move, between the Keystone Corridor and the station, in both directions;

<sup>96</sup> Only the view “after” improvement—with 45 mph crossovers, instead of the existing 30 mph crossovers—is shown.

**Figure 7-23: Harrisburg**



- Replace existing 15 mph turnouts and crossovers with 30 mph equivalents, thus preserving operating flexibility and perceptible trip time savings<sup>97</sup>; in particular, a universal 30 mph interlocking would be installed east of the "throat," or entrance to the station tracks; and
- Provide two additional station tracks and a new low-level platform to service the new Carlisle–Harrisburg–Lancaster trains, which would need to change direction in the station.

Such a redesign of the Harrisburg Station plan would improve trip times by about two minutes, improve operational flexibility and reliability, help to reduce maintenance costs, and accommodate potential new services.

<sup>97</sup> Refer to Figure 5-1 for the importance of raising speed limits from 15 to 30 mph in areas such as Harrisburg Station.

## **Chapter 8**

# **SUMMARY AND CONCLUSIONS**

This chapter recapitulates the nature and cost of the contemplated improvements to the Keystone Corridor, and presents major conclusions of the study.

### **RECAPITULATION OF CONTEMPLATED IMPROVEMENTS**

Table 8-1 lists the potential corridor-wide and site-specific improvements identified in Chapters 6 and 7. The table identifies the objectives and estimated cost of each line item. The estimated total cost of all the contemplated improvements (exclusive of rolling stock requirements and items not estimated in the study) stands at about \$686 million (1998 dollars).<sup>98</sup>

Further engineering work would support a more detailed segmentation, prioritization, and sequencing of these projects. As an example of segmentation, a major effort like the Harrisburg Station track reconfiguration—which this report presents in its broad outlines—would, if implemented, lend itself to subdivision into a number of subprojects. The engineers would then evaluate these subprojects in terms of their cost-effectiveness in fulfilling trip-time, capacity, and recapitalization needs. Experience on the NEC Project has shown that a disproportionately large share of the trip time benefits could result from a relatively small portion of the total costs, thus emphasizing the benefits of prioritization. Capacity and recapitalization projects can likewise be evaluated for their urgency and return on investment. Finally, the study's 2015 planning horizon would allow for a phased implementation of the contemplated betterments to match a staged introduction of service improvements on the part of the rail operators. Thus, if a decision is made to proceed with corridor development, closer scrutiny would assist participating entities in fashioning a detailed program that would be maximally affordable, timely, and efficacious.

### **STUDY CONCLUSIONS**

With its electric traction system, maximum authorized speeds up to 90 mph, ample capacity, excellent connectivity both with Center City Philadelphia and with Amtrak's New York–Washington route, and almost complete separation from highway traffic, the Keystone Corridor in many respects represents America's most intensely developed intercity rail

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<sup>98</sup> This engineering monograph does not address the means of financing the contemplated improvements. Some of these, however, are already funded through SEPTA as part of its commuter modernization program; others may require identification of additional sources of funds.

**Table 8-1: Potential Improvements to the Keystone Corridor**

|  | Principal Objectives Served |          |                               | Total Cost<br>(Millions of 1998<br>Dollars) |
|--|-----------------------------|----------|-------------------------------|---|
|  | Trip Time                   | Capacity | Recapitalization<br>and Other |   |
| <b>Corridor-Wide Investments</b>   |                             |          |                               |   |
| Curve Realignments   | •                           |          |                               | \$57  |
| Track Quality  | •                           |          | •                             | \$100                                       |
| Bridges, Culverts, Other Structures  |                             |          | •                             | \$15  |
| Electrification (Replacement of worn catenary wire within commuter territory. Does not address comprehensive rehabilitation or replacement of the electric traction system.) |                             |          | •                             | \$20  |
| Signalling and Train Control   | •                           | •        | •                             | \$199                                       |
| Stations and Parking   |                             | •        | •                             | not estimated                               |
| Operational Changes  | •                           | •        | •                             | not a capital cost item                     |
| <i>Total for Corridor-Wide Investments (exclusive of items not estimated)</i>  |                             |          |                               | \$391                                       |
| <b>Site-Specific Investments</b>   |                             |          |                               |   |
| Philadelphia Passenger Terminal Area through Overbrook Interlocking—Reconfiguration  | •                           | •        | •                             | \$60  |
| Bryn Mawr Interlocking Reconfiguration   |                             | •        |                               | \$9   |
| Relocate Paoli Station; Track and Interlocking Changes, Paoli through White and Frazer   | •                           | •        | •                             | \$63  |
| Glen Interlocking Reconfiguration  |                             |          |                               | \$9   |
| Track Rationalization, Glen to Caln (Includes Removal of Downs Interlocking)   |                             |          | •                             | \$6   |
| Thorndale Station Redevelopment; Thorn and Caln Interlocking Reconfigurations  |                             | •        | •                             | \$26  |
| Track Rationalization, Caln to Park (Includes Removal of Park Interlocking); A t Glen Station and Interlocking   |                             | •        | •                             | \$15  |
| Leaman Place (Paradise): New Interlocking and Station  |                             | •        | •                             | \$12  |
| Lancaster Reconfiguration  | •                           |          | •                             | \$11  |
| Operational Flexibility, Lancaster– Harrisburg (Roy and M t. Joy Interlockings; Middletown Eastbound Platform.)  |                             | •        |                               | \$25  |
| Airport Station  |                             |          | •                             | \$9   |
| Equipment support facilities at Harrisburg   |                             |          |                               | \$10  |
| Harrisburg Reconfiguration   | •                           | •        | •                             | \$42  |
| <i>Total for Site-Specific Investments (exclusive of items not estimated)</i>  |                             |          |                               | <b>\$295</b>                                |
| <b>Grand Total, Potential Keystone Corridor Improvements (exclusive of items not estimated and rolling stock)</b>  |                             |          |                               | <b>\$686</b>                                |

passenger infrastructure beyond the NEC main line.<sup>99</sup> However, some important components of the railroad have deteriorated noticeably since 1938, and the complex layout of interlockings, main tracks, and connections reflects pre-World War II needs—of heavy freight and long-distance passenger services—rather than the realities of today, often to the detriment of any high-speed corridor service that may be effected in future years.

Recognizing both the capabilities and limitations of this transportation resource, this monograph has arrived at the following technical conclusions, all of which are subject to a choice by the Commonwealth of Pennsylvania to implement improved service:

- A reliable, frequent 90-minute service (with three intermediate stops) between Harrisburg and Philadelphia's Suburban Station would be feasible on the Keystone Corridor by means of the contemplated corridor-wide and site-specific improvements and the provision of suitable all-electric equipment. Such a schedule would represent a 15-minute reduction from the 105-minute, seven-stop schedule routinely offered by Amtrak a quarter-century ago.
- Establishment of high-speed intercity services would not degrade, and could in fact improve, existing or proposed Keystone Corridor commuter services, and would be compatible with proposed Harrisburg commuter service as well—again, subject to the completion of the contemplated improvements.
- The contemplated improvements would provide the intercity rail passenger operator with the flexibility to offer several types of Keystone Corridor services, including—
  - (1) Harrisburg—30<sup>th</sup> Street Station Upper Level—Suburban Station and possibly beyond, via the Center City Connection.
  - (2) Harrisburg—30<sup>th</sup> Street Station Lower Level.
  - (3) Harrisburg—Philadelphia Main Line—New York via Zoo Interlocking and bypassing 30<sup>th</sup> Street Station.
  - (4) Harrisburg—30<sup>th</sup> Street Lower Level—New York.
- Not all these services would equally respond to market demands. Examinations of analogous, relatively short corridors in FRA's Commercial Feasibility Study (CFS)<sup>100</sup> clearly indicate the essentiality of trip times and convenient downtown-to-downtown service to the success of high-speed rail.

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<sup>99</sup> Other highly-developed corridors include the portion of the Empire Corridor between Albany and New York, and the portion of the California Corridor between Los Angeles and San Diego. These, however, are not electrified and have numerous highway-rail grade crossings.

<sup>100</sup> See, in particular, pp. 7-4 and 7-5 of the CFS report, *High-Speed Ground Transportation of America*—especially the analysis of the Los Angeles–San Diego city-pair, where automobile door-to-door travel times provide a challenging benchmark for all public transportation modes in a relatively short-distance corridor.

Therefore, services (1) and (3), if implemented, would best capitalize on high-speed rail's inherent advantages and allow the Keystone Corridor to expand its niche in Central and Southeastern Pennsylvania's transportation network. (Conversely, over the past two decades, the gradual substitution of services (2) and (4) for services (1) and (3) has arguably contributed to the line's one-fourth decline in ridership—from 1.2 million Keystone Corridor passengers in 1981 to 0.9 million in 1999.<sup>101</sup>)

- The Commonwealth of Pennsylvania and Amtrak in 1999 developed an agreement that implied the eventual substitution of services (1) and (3) for services (2) and (4). This study details certain improvements that would optimize the services offered under such an agreement, if effected. However, for the most part, the establishment of direct services need not await the achievement of full high-speed infrastructure capability and capacity envisioned in this report.
- Of the two options for providing a direct connection between the Keystone Corridor and NEC at Zoo Interlocking, the grade-separated New York–Pittsburgh Subway would appear to better capitalize on existing sunk investment, optimize operating flexibility, entail lower capital costs, and maximize the reliability and capacity of the line for all services. The Subway's operating advantages would be particularly apparent in the presence of the other improvements contemplated in this report. Inspections by Amtrak's engineering department preliminarily confirmed the structural soundness of the Subway as of the year 2000; theoretically, it could support direct Keystone–Northeast service in the near future, but could do so much better with a track upgrade from 15 to 30 mph. This conclusion, of course, is subject to the availability of appropriate equipment and to decisions by the Commonwealth of Pennsylvania on its priorities for intercity rail passenger service.
- While recognizing the marketing and service benefits of extending Harrisburg trains to Center City Philadelphia, SEPTA has expressed some concern about the impacts of such an extension on commuter trains, particularly in the peak periods. Operational analysis of the heavily-trafficked segment between 30<sup>th</sup> Street Station and Center City Philadelphia fell outside the scope of this report. The operating pattern for intercity service restoration on that segment would, however, need careful attention—for instance, with respect to precise turnback points and storage tracks for intercity trains. Especially essential would be close coordination of

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<sup>101</sup> The decline is even more marked because the 0.9 million in 1999 includes an undetermined, but probably significant, number of former Clocker passengers in the Philadelphia—New York portion of through Harrisburg–New York services. [Note: As this monograph goes to press, Amtrak has announced FY 2003 Keystone ridership of 886,000, confirming trends established in prior years.]


any restored intercity operations with existing commuter schedules, so as to avoid disruption to SEPTA's daily operations while bringing the benefits of more convenient intercity train services to travelers in Southeastern Pennsylvania. Beyond the issues of operational coordination, this conclusion is likewise subject to the availability of appropriate equipment and to decisions by the Commonwealth of Pennsylvania on its priorities for intercity rail passenger service.


- Other pending issues include the future of through freight service, if any, and the status of such inactive routes as the Trenton Cutoff. Although these questions may ultimately influence the design, scheduling, and operation of the Keystone Corridor, the absence of ready answers is not likely to adversely affect the future of this passenger-oriented railroad, under this monograph's working assumption that any incremental costs of through freight service restoration will be borne by the private freight railroad industry and not by the passenger-related entities.
- PennDOT and Amtrak in 1999 expressed the intention to invest in equipment and fixed plant upgrading on the Keystone Corridor. Any such upgrading effort, whenever effected, would necessitate detailed planning and engineering work, based on such potential improvements as those described in this report. Such additional studies would aim at prioritizing the improvements so as to allow potential corridor partners to achieve their short-term objectives while making the greatest possible progress toward long-term service and reliability goals with the limited resources at hand.
- Factors that any partners in Keystone Corridor development may find useful to consider in their joint planning would include but not be limited to the following:
  - **Beneficiaries**—the types of services, and the number of passengers, that would gain from each improvement. For example, improvements that will benefit both commuter and Amtrak services, or that would create travel time savings for a large number of rail travelers, might in some cases have a higher call upon funding than betterments that assist only one service or only a few riders.
  - **Performance projections.** For many travel-time-related improvements, there will be ways to calculate the minutes saved per dollar spent, thus yielding a priority order for this limited group of projects. Such other useful measures as return on investment can be applied to a wide range of project types.
  - **Urgency.** Improvements that address critical safety and reliability concerns—for example, grade crossing eliminations and the short-term

preservation of the signaling and electric traction systems—may acquire precedence over time-saving projects.

- **Funding sources.** Projects for which dedicated funding sources exist may receive priority over improvements that lack such funding. For example, a number of improvements in commuter territory may be able to make use of transit-related public funding. Similarly, rolling stock investments may be more easily financed through the private sector than fixed facility betterments.
- **Environmental factors.** As the Keystone Corridor does not represent a new service, and as the contemplated improvements lie mainly within the existing right-of-way, many of the potential betterments may ultimately prove to be exempt from environmental requirements. However, the need to properly fulfill environmental responsibilities must constantly concern corridor entities and their planners, and the applicable Federal, State, and local requirements would need to be discerned and acted upon well in advance of the intended implementation of covered projects.
- **Staging of service improvements.** The proposed 90-minute Harrisburg–Philadelphia schedule, while an achievable goal, is not immediately essential to the implementation of meaningful Keystone Corridor service improvements. Intermediate upgrades—including, for example, higher-performance electric-powered equipment, direct through trains between Harrisburg and New York, and service to Center City Philadelphia—would represent tangible progress to the traveling public and might be achievable much sooner than a 90-minute timing. Thus,—subject to the availability of funds and to the policy choices of the Commonwealth of Pennsylvania,—PennDOT, Amtrak, and SEPTA have an opportunity to plan a comprehensive, coordinated service that progresses deliberately and perceptibly, with the support of a carefully staged investment program, toward meeting their ultimate performance goals for the Keystone Corridor.

## GLOSSARY AND LIST OF ACRONYMS

| Acronym/<br>Term  | First<br>Occurs<br>on Page | Meaning  |
|-------------------|----------------------------|--|
| ADA               |                            | Americans With Disabilities Act  |
| CFS               |                            | FRA’s Commercial Feasibility Study of high-speed ground transportation, summarized in the 1997 report <i>High-Speed Ground Transportation for America</i> , available on-line at: <a href="http://www.fra.dot.gov/Content3.asp?P=515">http://www.fra.dot.gov/Content3.asp?P=515</a>  |
| C&O               |                            | Chesapeake & Ohio Railway  |
| CP                |                            | Control point—a term designating an interlocking, where trains can switch tracks. CP-Virginia is the current designation for the former “Virginia Interlocking.”   |
| CSX               |                            | CSX Transportation, Inc.   |
| CTP               |                            | Corridor Transportation Plan   |
| HP                |                            | High-level platform (at passenger stations)  |
| interlocking      |                            |  <p style="text-align: center;">Schematic of a universal, two-track interlocking (each track is represented by a single line).</p> <p>A location where carefully laid-out turnouts (“switches”) allow trains to move from one track to another. The trackwork and accompanying signals are all controlled by a mechanical apparatus and/or electric circuitry that is “interlocked” to prevent conflicting paths from being established for simultaneously passing trains. A <b>universal interlocking</b> on a multiple-track railroad allows trains to move from any track to any other track.</p> |
| FRA               |                            | Federal Railroad Administration  |
| Keystone Corridor |                            | The former PRR Main Line between Philadelphia and Harrisburg. (The segment between Harrisburg and Pittsburgh is <b>not</b> included for purposes of this report, although the entire Philadelphia–Harrisburg–Pittsburgh route is designated as a “high-speed corridor” under Section 1103(c) of TEA-21.)   |
| LP                |                            | Low-level platform (at passenger stations)   |
| MP                |                            | Milepost   |
| MAS               |                            | Maximum Authorized Speed   |

|                |  |  |
|----------------|--|--|
| NEC            |  | Northeast Corridor   |
| NECIP          |  | Northeast Corridor Improvement Project, a large Federal investment in the NEC main line, most of which occurred between 1976 and 1984.   |
| NEC South      |  | The portion of the NEC main line between New York, Philadelphia (30 <sup>th</sup> Street), Baltimore, and Washington.  |
| NS             |  | Norfolk Southern Corporation   |
| PennDOT        |  | Pennsylvania Department of Transportation  |
| PRR            |  | Pennsylvania Railroad  |
| SEPTA          |  | Southeastern Pennsylvania Transportation Authority   |
| slip switch    |  |  <p>Where two tracks cross at grade at an acute angle, a special piece of trackwork that allows for trains to either go straight or diverge to the other track. A very simple schematic of a slip switch appears to the left. Because slip switches are complex and labor-intensive to maintain, modern railway engineering practice is to avoid them where possible.</p> |
| STB            |  | Surface Transportation Board, successor to the Interstate Commerce Commission  |
| TEA-21         |  | Transportation Equity Act for the 21st Century, enacted June 9, 1998 as Public Law 105-178   |
| TPC            |  | Train Performance Calculator   |
| Trenton Cutoff |  | The former PRR freight bypass of Philadelphia, linking Harrisburg and points west with Northern New Jersey; also known as the “Morrisville Line.”  |